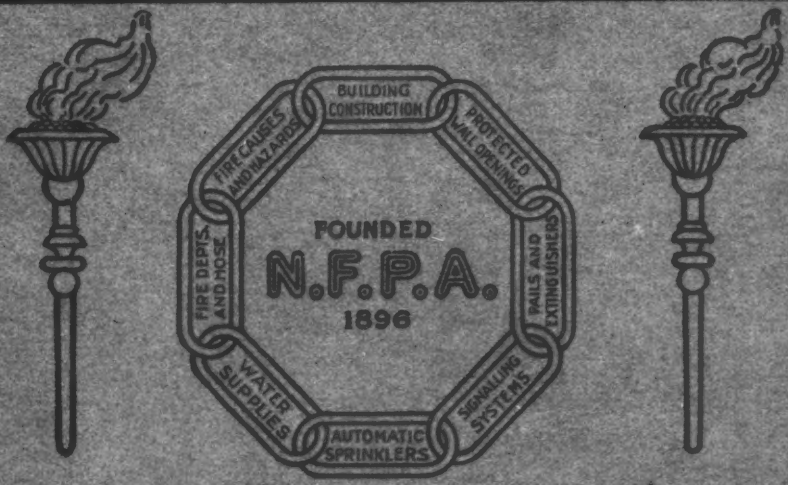
Vol. 28 APRIL, 1935 No. 4

# QUARTERLY
OF THE

# NATIONAL FIRE PROTECTION ASSOCIATION




*"To Promote the Science and Improve the Methods of Fire Protection and Prevention."*

PUBLISHED QUARTERLY AT BOSTON, MASS., BY THE
NATIONAL FIRE PROTECTION ASSOCIATION

Printed in U. S. A.

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Vol. 28 April, 1935 No. 4

# QUARTERLY

OF THE

# National Fire Protection Association

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# National Fire Protection Association

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Western Factory Insurance Association.
Western Sprinkled Risk Association.
Western Underwriters Association.
West Virginia Fire Underwriters' Association.
West Virginia Inspection Bureau.

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*Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.*

**Sprinklers shut off, even for one night, may lead to disaster. This picture shows the ruins of a Lynn, Mass., factory burned on Jan. 30, 1935.** (See report, page 334.)

# The Quarterly

Vol. 28 April, 1935 No. 4

**The Atlanta Meeting.** The thirty-eighth annual meeting of the Association, opening on Monday, May thirteenth, is another milestone in the progress of the fire prevention movement. Every year sees new problems in fire prevention and fire protection, on which is focused the thought of the leaders in this field in their annual assembly at the N.F.P.A. convention. The 1935 meeting has a full program of technical and popular reports, addresses and discussions on all phases of fire safety.

While the N.F.P.A. annual meetings are always "working conventions" and nothing is allowed to interfere with the business sessions, there will be ample opportunity to enjoy the Southern hospitality for which Atlanta is so justly famous. Members who attended the Memphis meeting in 1929 still speak enthusiastically of that interesting Southern convention, and all those who attend the Atlanta sessions will enjoy the happy combination of an interesting trip to a section of the South delightful in mid-May, a warm welcome from our Atlanta hosts, who are making elaborate plans for the entertainment of members and their ladies, an interesting convention program which deals with new developments in every important phase of fire prevention and fire protection, and the stimulus of personal contact with leaders in this field from all parts of the country.

* * * * *

**Political Turnover.** Thirty-five states now have the office of State Fire Marshal either as an independent state office or as a branch of the state insurance department or state police. Only five of the thirty-five state officials performing this function have been in office five years or more. Last year there were nine changes, the year before there were seven. The list of fire marshals in 1931 compared with the 1929 list (only two years) showed twenty-five changes out of the thirty-five. It is seldom that a state fire marshal, however earnest and efficient, survives a change in state government. The job is earmarked as a reward for political service rather than as a professional service affecting the life and property of the citizens. The same attitude does not apply in Canada where the public service is looked upon as a

profession and a career. Provincial fire marshals do not suffer rapid turnover. They remain in office year after year so long as they perform the proper functions of their office.

The office of State Fire Marshal is well established in most of the states and is here to stay. Isn't it about time that a movement was launched that would serve to protect the honest and capable state fire marshal from being thrown out just as he begins to learn something about the job?

* * * * *

**Whiskey Warehouses.** The Peoria, Illinois, whiskey fire on March 16 with a loss of $883,000, according to preliminary estimates, coming less than a year after the Lexington, Kentucky, whiskey warehouse fire of April 28, 1934, with a loss of nearly three million dollars, again calls attention to the hazard of this class of property.

Whiskey is a flammable liquid, stored in wooden containers, with high unit value, and enormous total values in a single fire area. While the probability of fire may be small, if fire does start from any cause in the ordinary whiskey warehouse a very heavy loss is probable. The rapid expansion of the distilling industry since the repeal of prohibition has presented a challenge to the fire protection engineer who has been confronted with the problem of devising effective fire protection for large whiskey warehouses which are so constructed and arranged that ordinary methods of fire protection are not applicable. Like other special problems in the fire protection field, a solution for this problem has now been presented through careful engineering based upon tests as described on another page of this QUARTERLY.

* * * * *

**A Word of Warning.** We have referred in previous QUARTERLY editorials to the embattled taxpayer. We have considerable sympathy with the taxpayers' leagues that are conscientiously striving to fathom the heavy burdens imposed by federal, state and municipal governments. The fire department is an expensive item in the average city budget. It is only natural that demands for economies and reductions in fire department expenditures are being made. Unfortunately too few citizens understand the complex functions of a modern fire department. Mobility of the department may depend on a number of fire stations excessive to the untrained eye. The importance of an adequate fire alarm system in this telephone age may be overlooked or discounted. Salvage and rescue squads, training school facilities, inspection supervisors, etc., may appear unnecessary frills to anyone unaware of the importance of these units. It cannot be argued that economies may not be effected, but wholesale slashing of a fire department budget without the most careful and expert study of all the factors involved is not only unwise but by affecting the morale of the personnel and by weakening essential functions may be positively dangerous in the creation of a conflagration possibility.

The remarkable reduction in fire losses of the last two years encourages the casual thinker to the conclusion that a favorable loss record in his city is reason enough to cut fire department expenses. We must depend on the level headed city official and citizen to promptly put the brake on any movement with this sort of fallacious reasoning behind it.

* * * * *

**Replacement Programs.** The manufacturers of fire apparatus for municipalities have had some lean years. Expenditures for new pumpers and ladder trucks have been rather ruthlessly thrown out of many submitted budgets. Apparatus won't last forever, however, and the past few months show substantial evidence of a minor boom in the sales of fire equipment. All too many cities have had the slipshod and shortsighted policy of forgetting all about the condition of their fire department equipment and then being suddenly confronted with the need of wholesale replacements necessitating a bond issue. It is much more logical to adopt a replacement program of say one unit of fire apparatus for each fifteen units each year. This will establish a "pay as you go" plan which is far preferable to the bond issue or special tax levy.

* * * * *

**The Importance of the Volunteer.** The development of the Volunteer Firemen's Section launched during the fall of 1933, has been a liberal education in geography to the members of the N.F.P.A. executive staff. Prior to 1933 the efforts of the N.F.P.A. through its contact with members and through its field service had been largely directed to the approximately five hundred cities on the North American Continent of a population of 20,000 or more. Now through the medium of the new section the N.F.P.A. is making regular contact every month with some twelve thousand additional cities and towns. What a new and vital field for N.F.P.A. service this has opened up! Our Farm Committee has pointed out that over half of all the fire loss is in the rural areas. Studies made in the executive office indicate that there is almost four times as much fire apparatus manned and operated by volunteer fire departments as by the full paid departments of the large cities. There are, for example, 261 volunteer fire departments in North Dakota, 389 in Texas, 615 in Ohio and 1216 in Pennsylvania. These departments are the principal influence on the safety to life and property from fire in their communities. Volunteer firemen are a cross-section of the business life of the community they serve. They are bankers, tradesmen, mechanics, farmers, politicians, factory workers, garagemen, lawyers, and city commuters. Volunteer fire companies range from a few men with a hose reel or bucket brigade to several hundred men with 1000-gallon pumping engines and 85-foot aerial ladders. Our new section apparently appeals to all types and kinds of volunteer firemen. Thirty-one volunteer firemen from Salmon, Idaho, are

members of the Volunteer Firemen's Section. So are fifty-nine men from New York Mills, N. Y., twenty men from Signal Mountain, Tennessee, and twenty-four men from Juneau, Alaska. Already over eight thousand volunteer firemen have enrolled in the section from forty-four states, eight Canadian provinces, and even from South America. Through this new section the N.F.P.A. is reaching the Main Streets of America. We believe the influence we can exert through this new field of our efforts will have a profound effect on the fire loss record in the ensuing years.

* * * * *

**Police Radio Cars.** The radio equipped police cruising car may play an important part in fire control in addition to its primary function of crime suppression, as convincingly illustrated by the following letter from a Newark member.

One evening last winter one Ed Mausse discovered a brisk little blaze eating its way through a garage at 65 Houston Street, Newark, N. J. Without hesitation Ed struck out for the nearest fire alarm box and sent in the alarm. Then he returned expeditiously to see if he could do anything to halt the progress of the Red Demon until the fire department should arrive.

What was his astonishment upon his return to the scene which he had quitted only a few minutes before, to discover a Newark Radio Police Car in front of the garage, the fire out and Radio Policemen Foster and Brinkman putting back into their car the one-quart carbon tetrachloride and the 15 lb. carbon dioxide extinguishers which they carry as standard equipment.

Mr. Mausse's alarm was received simultaneously at Fire Headquarters and at the Police Headquarters radio dispatcher's desk. The latter had instantly relayed the call and before Mausse's hand had left the box Messrs. Foster and Brinkman were on the run, siren shrieking, to the half-a-mile distant garage.

Every Newark radio police car is equipped with two extinguishers and every Newark radio policeman has had special training in how to use them effectively and efficiently. This story is only one incident in the series of thrilling adventures these extinguishers have had in the last two months.

In addition to the value of prompt extinguishment of incipient fires which would otherwise have to await the arrival of the heavy apparatus, the prompt response of the Newark radio cars is an important factor in discouraging false alarms.

# Meeting of Board of Directors.

## Atlantic City, January 19, 1935.

### Members Present.

Albert T. Bell, Chairman
Harold L. Miner, President
George W. Elliott, Vice-President
Frederick T. Moses, Past President
Sumner Rhoades, Past President
Franklin H. Wentworth, Managing Director

| | |
|---|---|
| Eugene Arms | Chas. W. Mowry |
| H. T. Cartlidge | S. L. Nicholson |
| A. O. Dawson | C. W. Pierce |
| W. F. Hickey | D. J. Price |
| W. E. Mallalieu | A. R. Small |
| S. D. McComb | Richard E. Vernor |

There were also present Percy Bugbee, Assistant Managing Director, Robert S. Moulton, Technical Secretary, and H. E. Newell, Chairman, Committee on Gases, N.F.P.A.

### Business Transacted.

1. A resolution on the death of Past President Dana Pierce presented by the Chairman of the Board was unanimously adopted.

2. The program of the 39th annual meeting was discussed and referred to the Program Committee.

3. Executive Office reports on Membership, Publications, Advertising, Field Service Activities and Volunteer Firemen's Section were reviewed without action.

4. The sub-committee of the Board on Primary Electric Service Installations appointed at the June 1934 meeting, pursuant to a motion at the annual meeting of the Association by Dr. M. G. Lloyd, reported as follows:

> The committee is of the view that the Board of Directors should report that the National Electrical Code is presumed to cover the practical safeguarding of electrical hazards to buildings, their contents and occupants, including primary, as well as secondary supply wires and related equipment. The nature of such safeguarding is for the Electrical Committee to determine.

The report was accepted.

5. Preparation of a protest concerning the building code project of the American Standards Association was recommended for adoption by the Fire Protection Group.

6. It was unanimously voted to recommend to the Fire Protection Group the renomination of Mr. A. R. Small as candidate of the Group for election to the Board of Directors of the American Standards Association for the three years' term beginning January 1, 1935.

7. The Board received a report from the President concerning his request to the Chairman of the Committee on Field Practice that a sub-committee be organized to consider the subject of grenade type fire extinguishers. The President also read a letter from a manufacturer of such devices requesting interim action by the Board on the matter. The sub-committee of the Committee on Field Practice had advised the President that its view is:

> That there is a need of small extinguishing devices upon fires in their incipient state, occurring in properties such as dwellings, when such fires are promptly discovered.

This view, if approved by the Field Practice Committee, is to be reported by it to the Association in May. Accordingly the Board voted not to take the interim action suggested.

8. The report of the Committee on Technical Committee Procedure was considered and approved, and the committee was continued for another year with the same personnel: C. W. Pierce, Chairman, George W. Elliott, C. H. Haupt, C. W. Mowry, A. R. Small.

This report covered, among other items, the following:

(a) The authorization of new committee activities as follows: Flammable Liquids, oil burning equipments for tailoring and pressing establishments; Gases, liquefied petroleum gases for use as automotive fuel; Manufacturing Hazards, high pressure water spray systems for extinguishing flammable liquid fires.

(b) The approval of scope statements for technical committees designated by asterisks in the 1934-35 Year Book.

(c) Approval of a change in the name of the Committee on Manufacturing Risks and Special Hazards to Committee on "Manufacturing Hazards."

(d) Report on supplementary revisions in the Regulations for the Storage, Handling and Use of Pyroxylin Plastics in Factories Making Articles Therefrom, recommended by the Committee on Hazardous Chemicals and Explosives, referred to the Committee on Technical Committee Procedure with power, which have been approved as follows:

Revise the footnote to paragraph 14 (g) to read:

"See Sections 604-2 and 1009 of the Fifth Edition," and the footnote to paragraph 15 (b) to read: "See Article VI of the Fifth Edition."

Revise paragraph 18 (b) to read:

"(b) Only incandescent electric lights shall be permitted. These shall be protected against mechanical injury by substantial wire guards where necessary. In rooms or locations where there are flammable vapors or dusts, compliance with Article 32 of the National Electrical Code, covering Class I and Class II hazardous locations, may be necessary, depending upon the hazard."

Insert new paragraph 18 (d) as follows, relettering present paragraph (d) to (e):

"(d) Motors or generators having brushes or sliding contacts shall be of the totally-enclosed, enclosed-fan-cooled, or enclosed-pipe-ventilated types, or shall be otherwise arranged to minimize the danger from sparks, as provided in sub-paragraphs 2 to 6, inclusive, of paragraph (h) of Section 3402 of the 1933 edition of the National Electrical Code."

Revise paragraph 20 (d) to read as follows:

"(d) In addition to the above, there shall be at least one small hose connection for each 5000 sq. ft. area, which shall be equipped with 50 to 75 ft. of approved hose, or one or more approved 2½-gal. extinguisher of the type using water, or water solution, consisting largely of water (foam not included) to obtain maximum cooling effect."

Insert in paragraph 20 (e) a reference to carbon dioxide fire extinguishers and a general reference to Class C extinguishers, making this paragraph read:

"(e) Around large motors and other electrical equipment where special protection is needed, approved carbon tetrachloride, carbon dioxide, or other Class C fire extinguishers shall be provided.

"NOTE: See Regulations for the Installation, Maintenance and Use of First Aid Fire Appliances."

Revise paragraph 102 (b) of the additional section to read:

"(b) Such rooms shall be protected by a system of automatic sprinklers approved for such occupancies."

9. The list of changes in technical committees recommended by the Committee on Technical Committee Procedure was approved, including the following appointments subsequent to the printing of the 1934-35 Year Book:

**Dust Explosion Hazards**

W. J. Fairbairn, Western Factory Insurance Association, in place of L. J. Borland (resigned), Conference of Special Risk Underwriters.
H. W. Brown, replacing H. J. Carr, U. S. Department of Labor.

**Farm Fire Protection**

S. O. Cook, replacing M. O. Cook, Motor Fire Apparatus Manufacturers Association.
John W. Strohm, Fire Marshals Section, N.F.P.A.

**Fireproofing Processes**

T. R. Truax (committee member, Forest Products Laboratory, U. S. Forest Service), chairman in place of the late Dana Pierce.
A. J. Steiner, Underwriters' Laboratories, in place of Dana Pierce.

**Protection of Records**

Richard G. Tobin, National Association of Credit Men, replacing Chester H. McCall.

**Salvaging Operations**

Thomas C. Shannon, New York Fire Patrol, replacing J. O. Schwank.

10. A communication from the International Association of Electrical Inspectors, requesting additional representation on the Electrical Committee, was read and the Secretary instructed to reply to the Association, expressing appreciation of its coöperation in the activities of the Electrical Committee and regret that it is not considered practicable to increase its representation as this would disturb the balance of the committee as approved by the American Standards Association.

11. Approval was granted for the presentation of two names to the next annual meeting of the Association for election to honorary membership.

### Amendment, Regulations on Technical Committee Procedure.

The Board of Directors by letter ballot, has amended the first sentence of par. 52 of the Regulations Governing Technical Committee Procedure (Year Book 1934, page 6) to read as follows:

Except by special permission of the Board of Directors or by unanimous consent of the annual meeting, no technical committee report shall be presented to the Association in annual meeting which is not received by the Secretary before March 15 of that year for advance publication.

# The Petroleum Industry's Fire Losses.

Annual fire losses of the petroleum industry averaged less than 14 cents per $100 of total value of plants and equipment during the period 1930-1933 inclusive, according to statistical data compiled by the American Petroleum Institute and released in an article by David V. Stroop, Staff Engineer, in the A. P. I. Quarterly for January, 1935. These compilations of fire loss experience are of interest as one of the first, if not the first, comprehensive attempt on the part of a major industry to make a systematic check on its actual fire experience, using records compiled by the industry itself. The results are summarized in the accompanying table. It is of particular interest to note the wide range in fire loss experience between different classes of petroleum property. A study of this table shows the fallacy of the popular idea that all types of oil storage and handling are more or less equally hazardous.

**Fire Loss Experience of Petroleum Industry Plant and Equipment; Not Including Oil.**

Average of Years 1930-1933 inclusive.

| Development, Production and Storage | Number of Properties | Total Value Subject to Fire Loss | Average Value per Property | Total Fire Loss | Loss per $100 of Property Value |
|---|---|---|---|---|---|
| Oil leases | 4544 | $86,987,827 | $19,143 | $164,994 | $0.190 |
| Tank farms | 340 | 74,798,666 | 219,996 | 33,326 | 0.045 |
| **Refining of Petroleum and Manufacture of Natural Gasoline** | | | | | |
| Refineries | 93 | 424,402,822 | 4,563,471 | 661,665 | 0.156 |
| Natural Gasoline Plants. | 167 | 19,837,103 | 118,785 | 13,284 | 0.067 |
| **Marketing of Petroleum Products** | | | | | |
| Bulk Terminals | 77 | 16,924,005 | 219,792 | 9,600 | 0.057 |
| Bulk Plants | 9,184 | 108,639,608 | 11,829 | 86,621 | 0.080 |
| Service Stations | 17,527 | 93,685,547 | 5,345 | 46,302 | 0.049 |
| **Transportation of Petroleum and Its Products** | | | | | |
| Pipe Line Stations | 650 | 48,593,243 | 74,759 | 18,206 | 0.037 |
| Tank Trucks | 14,052 | 17,338,277 | 1,234 | 17,468 | 0.101 |
| Tank Vessels | 336 | 129,220,917 | 384,586 | 405,360 | 0.314 |
| **Unclassified** | | | | | |
| | | 49,989,640 | | 17,213 | 0.034 |

This tabulation includes only values and losses on plant and equipment. Values or losses on products or stocks of crude oil, costs due to personal injury to employees, damage to other than oil company property, and losses due to interruption of operations are not included. The data, obtained from the several oil companies listed at the end of this article, represent an indeterminate fraction of the total value of the industry's plant and equipment subject

to damage by fire. It is known that there have been a number of fires during the period on which no reports have been received and which are not represented in this summary. On the other hand, there are other companies not represented in the present compilation which have had little or no loss, and their experience might more than offset the unreported losses in a complete record of all the industry.

The several classifications in the tabulation are explained as follows. It is explained that owing to variations in company practice it is impossible to define closely the types of equipment or operations in the several classes, or further to subdivide classes.

#### Development, Production, and Storage of Petroleum.

This division is subdivided into oil leases and tank farms. Under oil leases there may be wide differences in the type of operations. The lease may be under any stage of development, *i.e.*, rigging up, drilling or completing a well; producing oil under natural pressure or by pumping; or, cleaning or re-tubing the well.

Under tank farms there are included those properties on which are stored large quantities of crude petroleum. In some cases, however, companies also include the storage of products, such as fuel oil and gasoline, under this class if the storage is not on the property of a refinery, bulk terminal, or bulk plant.

#### Refining of Petroleum and Manufacture of Natural Gasoline.

This division is subdivided into refineries and natural gasoline plants. The properties included under refineries may differ greatly in size and character of operations; some may consist of simply a few small distillation units operating at low temperatures and pressures; others may include every known type of processing equipment for the distillation, cracking, treating, and blending of petroleum and its products. Natural gasoline plants may be either of the compression or absorption type.

#### Marketing of Petroleum Products.

This division is subdivided into bulk terminals, bulk plants, and service stations.

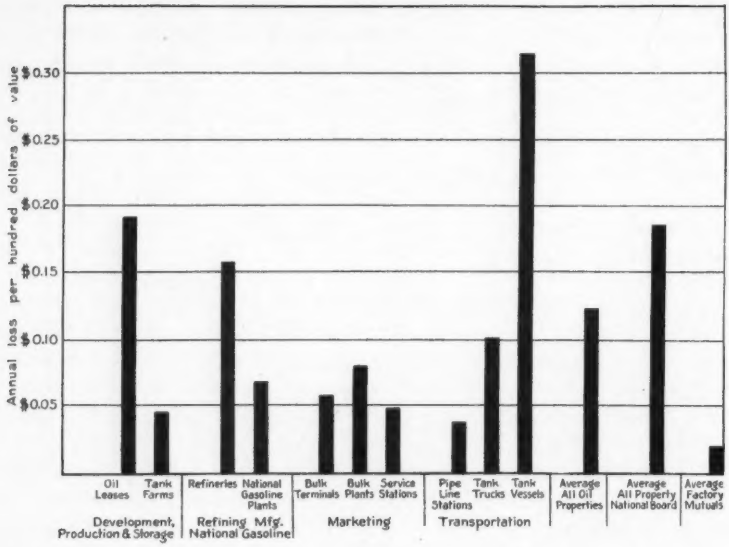
The term bulk terminals is used to designate those properties, usually of considerable size, to and from which refined products are delivered by tankers and barges. The smaller inland properties, usually smaller than bulk terminals, at which refined products are stored, are classified as bulk plants.

Under the heading of service stations are grouped those properties on which refined products are sold at retail to the public.

#### Transportation of Petroleum and Its Products.

This division is subdivided into pipe lines, tank trucks, and tank vessels.

Fire losses on pipe-line properties are confined largely to the pipe-line pumping stations and such working tanks as may be used in conjunction with




the stations. The figures given include both crude and gasoline pipe lines. The losses given for tank trucks apply only to damage to the vehicle, and not to the products being transported. The data on tank vessels include both seagoing and inland water tank ships and barges engaged in the transportation of crude and refined oils.

No attempt has been made to compile a record of fire losses incident to the transportation of petroleum and its products in tank cars.

**Unclassified Properties.**

Properties ranging from crude storage reservoirs to office buildings are included under this miscellaneous item.

Owing to the limitations of this tabulation the results cannot be compared directly with other fire loss ratio figures. It is of interest to note, however, the losses reported by the National Board of Fire Underwriters for fire and lightning insurance business for all classes of property in the United States, 1930-1933, averaged $0.185 per hundred dollars of value, while the average loss as shown by the present compilation for the same period is $0.138. Many of the oil companies participating in the tabulation are large concerns which maintain a high standard of plant equipment and fire protection, carry their own fire insurance, have their own fire protection organization, and thus may be more or less comparable with large high grade manufacturing plants. On this account it is also of interest to make comparisons with the loss experience of the Associated Factory Mutual Fire Insurance Com-

panies, which has recently averaged about two cents per hundred dollars of value, although this experience is limited to superior property largely under automatic sprinkler protection, and for the reasons cited above this figure also is not directly comparable with the experience of the oil industry.

### Companies Reporting.

The data presented in this article were compiled by the American Petroleum Institute from reports by the following companies:

Ajax Pipe Line Company
Amerada Petroleum Corporation
The Atlantic Producing Company
The Atlantic Refining Company
Canfield Oil Company
Carter Oil Company
Cities Service System
Colonial Beacon Oil Company
Continental Oil Company
General Petroleum Corporation of California
The Globe Oil and Refining Company
Gulf Production Company
Humble Oil and Refining Company
Humble Pipe Line Company
Imperial Pipe Line Company
Kesbec, Inc.
Oklahoma Pipe Line Company
The Pennzoil Company
The Pure Oil Company
Shell Eastern Petroleum Products, Inc.
Shell Oil Company
Shell Petroleum Corporation
Shell Pipe Line Corporation
Socony-Vacuum Oil Company, Inc.
Sinclair Refining Company
Standard Oil Company of California
Standard Oil Company of Louisiana
Standard Oil Company of New Jersey
Standard Oil Company of Pennsylvania
Standard Pipe Line Company
Standard Shipping Company
Sun Oil Company
Superior Oil Works
Sylvestre Oil Company
Texas Pacific Coal and Oil Company
Tuscarora Oil Company
Union Oil Company of California
White Eagle Oil Corporation

# Ice in Cold Storage Sprinkler Piping.

On the morning of October 12, 1934, the seven-ton flywheel of an engine in a sprinklered fire-resistive cold storage warehouse in Chicago ruptured from an undetermined cause. The broken segments severed water mains, ammonia lines and other piping. Shortly after the release of ammonia from the broken piping the mixture of ammonia vapor and air exploded. Ignition was from electric arcing or from a fire caused by broken electrical equipment. The explosion seriously damaged the building and broke windows in near-by structures for a distance of several blocks in all directions. Two men were killed and several were injured. The resultant fire damage was slight.

The explosion crippled the fire protection system of the plant and all of the water in the 40,000-gallon gravity tank discharged through the broken piping. As the dry valves controlling the sprinkler systems were tripped by the force of the explosion, or operated in a normal manner following the release of air pressure through the ruptured piping, a careful investigation was made to determine whether water had entered the piping and frozen.

Extensive ice formations were found in the sprinkler piping of several of the systems, including one controlled by a dry valve which did not trip. These latter formations could in no way be attributed to the explosion.

A similar investigation was made in another cold storage warehouse, of brick semi-mill construction, with special reference to the sharp freezers, although sprinkler piping in coolers that had formerly been freezers was also examined. As the investigations progressed many serious conditions were disclosed. Ice formations were found and removed, and necessary alterations were made to the sprinkler systems to eliminate, in so far as possible, the probability of any similar recurrences.

### Fire-resistive Warehouse.

The sprinkler equipment in this plant was installed in 1917. It consists of a wet system in the sub-basement and ten dry pipe systems in other areas. Prior to the explosion the air compressor for the dry systems took air from the engine room, where the relative temperature and humidity are rather high. This arrangement has been changed and air is now taken from a sharp freezer at a temperature of about —12° F. This should largely eliminate condensation in the piping.

The piping was first examined in the sharp freezers, where the average temperature is about —12° F. Subsequently an investigation was made of the piping in the coolers, where the temperatures are above freezing.

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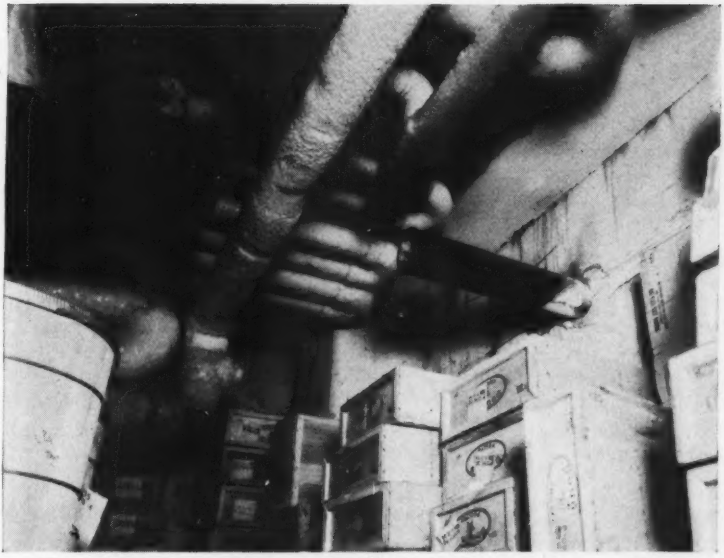
Extracted from a special report by the Chicago Board of Underwriters (Member N.F.P.A.)



**Sharp freezer room where sprinkler piping was found almost completely stopped by ice. This picture shows a 20-in. section of a 5-in. sprinkler main removed for inspection. Frost-covered pipes at ceiling are brine pipes.**

Sprinkler heads were removed from the ends of branch lines and the volume and pressure of the air thus released were noted. This method failed to disclose the exact condition of the pipe, although if no air or very little air was released it was obvious that there was a blockade somewhere in the piping. The piping was then dismantled for a more complete examination.

As the work progressed, one-inch peepholes were tapped into 90° elbows leading into the sharp freezers and the branch lines at the end of the cross-main were removed. By looking into one of the openings and holding a bright light at the opening on the opposite end, any blockade within the pipe could be readily detected. Riser nipples were then removed and branch lines were backed out. By removing the elbow at the end of the ¾-inch pipe this same method of examination was followed.

Ice formations were found in the sprinkler piping on all of the floors containing sharp freezers. Many of these ice formations presented serious obstructions to the flow of water and in some cases completely filled the pipe for distances up to fifty feet.

Two kinds of ice were found, one typical condensation formation and the other solid ice. The solid ice was found in two varieties, one more or less clear and apparently the result of a single freezing, while the other was in layer formation. These layer formations indicated several trippings of the

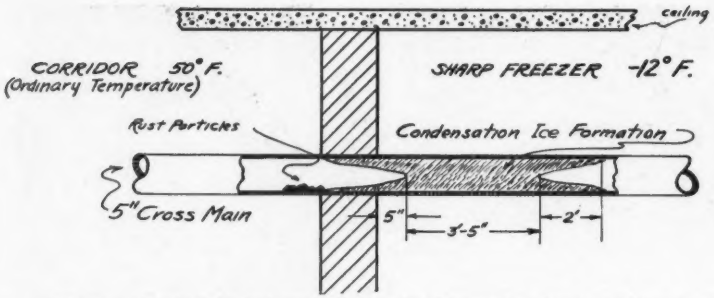



**Diagram showing typical condensation ice formation where sprinkler piping entered a sharp freezer room.**

dry valves and consequent flooding of the systems, with a resultant freezing of some of the water either before it could drain out or because it could not drain back on account of improper pitch of the piping, which was probably due to settling of the building, loosening of hangers, etc.

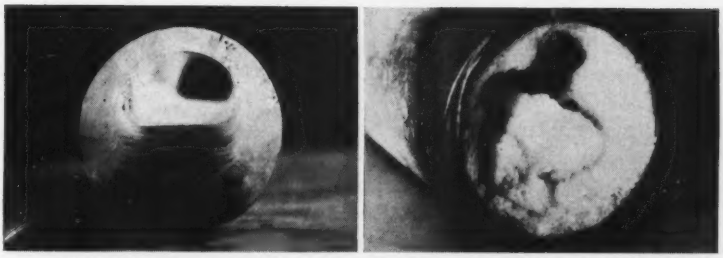
Some of the ice formations may have been the result of changes of temperature due to the alternate use of rooms as freezers and coolers. When converted to coolers ice in the pipes would melt and the water would collect at low points, where the piping did not have the proper pitch for drainage, with subsequent freezing when the rooms were again used as sharp freezers.

The condensation ice or snow was, as a rule, found just inside the wall of the freezer, where the sprinkler crossmain passed from a comparatively warm area into an area of sub-zero temperatures. The size of the piping seemed to have no particular significance, as ice was found in piping ranging from 5-inch to 2½-inch. In most cases the length and compactness of the ice formations would have prevented the flow of water. In one section the dry pipe valve failed to trip due to paint on the moving parts. Ice formations in this section were attributed largely to condensation.

### Semi-Mill Constructed Warehouse.

The sprinkler system in this warehouse is similar to that in the fire-resistive cold storage warehouse previously described. Sprinkler risers are located in unheated hallways with crossmains passing through a wall into the sharp freezers. Air supply for the dry systems is taken from the engine room.

In this plant ice formations found were similar to those in the other warehouse, and the condensation ice was found in about the same relative position. Condensation formations in this plant were not very extensive, however. Brine had been used at some time when testing for leaks and much of the piping showed clearly the corrosive effects of this brine in the form of sediment, rust, etc., that was frozen in with the ice. In one crossmain, at the riser supplying all the heads in a section of the third floor, a blank sheet metal



**Left: Ice removed from a section of 3-in. pipe, with twelve distinct ice strata, due to repeated trippings of dry pipe valve. Right: Hoar frost from condensation obstructing a sprinkler pipe in a sharp freezer. In many cases pipes were found completely stopped by ice.**

flange was discovered. The flange was, no doubt, installed at some time when tests for air leaks were being conducted on other floors supplied by this same riser and was not removed upon completion of the tests.

All of the sprinkler piping on the floors occupied by freezers was found to have contained ice formations of a serious nature, with the exception of the piping where the blind flange was located. The piping on this floor still contained brine, and a considerable amount of this piping was in very poor condition as a result of the corrosive action of the brine. Most of this piping has been replaced. Improper drainage, due to the settling of the building, accounts for many pockets found in the sprinkler piping in which numerous ice formations were found.

### Methods of Removing Ice.

Two methods of removing the ice from the piping were employed, one manual and the other electrical. The manual method consisted of the removal of the affected piping to a warm area and allowing the ice to melt until it could be removed from the pipes. The electrical method consisted of heating the pipes by means of a direct current of 1400 to 1900 amperes at from 6 to 10 volts. Electrical connections were made at each end of the pipe to be thawed and provisions were made for the water to drain from the pipe.

When the crossmain only was involved, the electrical method was very satisfactory. The manual method proved more satisfactory when the branch lines were involved. The electrical method resulted in the complete removal of all moisture; the piping was found perfectly dry after thawing.

### Summary and Conclusions.

All sprinkler piping installed in areas where temperatures below freezing are maintained is subject to ice formations within the piping. Aside from condensation ice formations, the extent of this condition will depend largely on previous trippings of the dry valves.

Tests made with water in sprinkler piping placed within a sharp freezer, which was maintained at $-12^{\circ}$ F., indicate that, with properly pitched piping.

if the system is entirely drained within twenty minutes after flooding, little or no ice will be formed. Correct drainage is a very important feature, because if there are low spots in the system ice will be formed in these at the time of the first flooding.

Air for dry systems should be taken from sharp freezers where sub-zero temperatures are maintained. This should, in a large degree, eliminate condensation formation within the piping.

Condensation ice formations within sprinkler piping sometimes form serious obstructions and would undoubtedly have resulted in a sprinkler failure in some of the areas examined had fire occurred. Some crossmains, ranging from $2\frac{1}{2}$ to 5 inches in diameter, were found totally obstructed by ice to a length of from 5 to 50 feet. No condensation ice was found in any of the branch lines.

Conditions found at the brick semi-mill cold storage warehouse showed the corrosive effects of brine on sprinkler piping. Air under high pressure should be used for test purposes instead of brine. At this warehouse numerous leaks have developed and much of the sprinkler piping has had to be replaced, due to the corrosive effects of the brine used when testing.

The present methods of installation do not provide fittings to facilitate inspection of the sprinkler piping in sharp freezers. The installation of flanged connections and other readily removable fittings at strategic points would do much to encourage periodic inspections of the sprinkler piping within these areas and would materially reduce the cost of such inspections.

In most cases accidental tripping of dry pipe valves can be laid to poor maintenance, although there are few dry systems which have been installed for a long period of time that have not tripped at some time or other. Many of the ice formations encountered have been the result of accidental tripping of dry pipe valves. Daily or more frequent inspections of the air pressure maintained on the dry systems in areas subject to sub-zero temperatures will to a considerable extent eliminate such accidental trippings. The attachment of low air pressure signals to each dry system would be desirable. Central station supervision, where available, is recommended.

In cold storage warehouses sharp freezers are at times converted into coolers and coolers are changed to sharp freezers, with a variation of temperature from below zero to above freezing. In the case where the sharp freezer is converted into a cooler at temperatures above freezing, any ice formation present in the sprinkler piping at the time of conversion will melt, and if the piping is properly pitched no harm will be done. If the drainage is faulty the water will settle in the low points, remaining there until such time as sub-zero temperatures are again maintained, at which time ice will be formed. If the drainage is especially faulty several such changes will result in much of the piping eventually becoming totally obstructed with ice.

# Whiskey Warehouse Fire Tests.

By Clarence Goldsmith, K. M. Ayton and E. Schuenemann.*

The dependability of automatic sprinkler protection and the proper design for sprinkler systems in unfloored rack warehouses has been a debatable subject in the minds of underwriters, fire protection engineers and rating authorities because of the very limited fire experience in sprinklered unfloored rack warehouses and authenticated data reflecting this experience upon which definite conclusions could properly be based.

The addition of another rack warehouse by Hiram Walker & Sons, Inc., at Peoria, Ill., to be followed by the addition of similar warehouses, emphasized the need of obtaining reliable engineering data upon which conclusions might be based. With this object in view, a comprehensive program of tests was decided upon and conducted, largely on the premises of Hiram Walker & Sons, Inc., and their architects, Messrs. Smith, Hinchman and Grylls, assisted in the designing of the equipment and the determination of the test procedure by the authors.

Preliminary tests were conducted at Youngstown, Ohio, to take advantage of existing equipment used in previous tests to determine proper spacing and distribution characteristics of sprinklers, burning characteristics of barrels and racks, and extinguishing ability of sprinklers.

## The Warehouses.

There are two large unfloored open rack type bonded warehouses with heavy brick buttressed walls and heavy interior wood frame, vertical and horizontal bracing, located in center of the Peoria distillery plant, 67,700 barrels capacity each; equipped with a wet system of automatic sprinklers, three-source water supply, with a proprietary supervisory system.

Each structure is 185 ft. long, 152 ft. wide outside dimensions and approximately 105 ft. above grade to peak of roof, and 4 ft. below grade to basement floor; approximately 63 ft. from grade to eaves. There are no floors except 13 ft. wide center aisleways at each 8 ft. level, where floors are plank on wood beams supported by rack uprights.

Supports for racks and roof are heavy vertical "fir" timbers, 6 in. by 12 in. at base and 6 in. by 8 in. at higher levels. Vertical members support

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This article is extracted from a complete report on tests to determine the efficiency of automatic sprinkler systems entitled "Fire Protection of Unfloored Rack Warehouses," copyrighted 1935 by Hiram Walker & Sons, Inc., Peoria, Ill.

the 4 in. by 5 in. fir "dunnage" for racking barrels and catwalks. The entire rack structure is bolted together. The basement floor is concrete. The finish is open throughout with no concealed spaces. The roof is of gabled type, with 10 ft. offset. The roof is of asbestos, composition board insulation and metal on wooden supports.

Heating is by automatically humidified hot air circulated through a duct system, with return air drawn through basement floor openings. Other details of the construction, arrangement and equipment of these warehouses are given in the complete report, but are not included in this extract as they have no particular bearing on the tests.

The buildings are protected by a complete automatic sprinkler system with ample three-source water supply. Heads are placed under alternate "catwalks" spaced 7 ft. 4 in. apart on 10-head lines. A complete complement of sprinklers is installed under roof and aisle floors.

### Sprinkler Distribution and Barrel Burning Characteristics.

Tests with manually operated sprinklers to determine distribution characteristics under various conditions, and proper location and spacing of sprinkler heads were conducted at Youngstown on the premises of the "Automatic" Sprinkler Corporation of America, in August, 1934. The results of these tests were confirmed by supplementary tests on November 20, 1934, employing a filled rack unit of the same design as the Peoria warehouse racks, with sprinklers located and spaced as in the Peoria warehouse. When water was properly distributed, without obstruction by structural members or barrel heads, a uniform downward distribution was obtained, together with a complete enveloping effect on the circumference of barrels and the rack structure coming within the range of the open sprinkler heads. On January 4, 1935, similar results were obtained in Peoria.

Barrel pressure tests, to develop the ability of barrels to withstand internal pressure, indicated that new, eight-hoop, white oak, fifty-gallon whiskey barrels will withstand from 36 to 60 lbs. hydrostatic pressure when failure through cracking of the head piece occurs, relieving the pressure. Tests at Youngstown showed that barrels filled with a 54% alcohol mixture (the equivalent of 109 U. S. proof whiskey) to within 7 inches of the top and directly exposed to a fire, failed to build up internal pressure in excess of a few ounces. Leakage from such a new barrel burning took place in about 15 minutes at the seams and in about 30 minutes at the head. Application of water to this barrel at the conclusion of the 35-minute fire test extinguished the fire and reduced the free leakage to a nominal amount. Final examination of this barrel showed that the charring had progressed to within ¼ in. to ⅜ in. of the interior face of the staves.

A similar barrel burning test was conducted at Peoria on January 3, 1935, employing re-used barrels with an alcohol-water mixture (109 U. S.

proof), supported by an exact reproduction of the warehouse rack structure, but employing a much larger and more severe fire than was used in the Youngstown tests. The results of this Peoria test paralleled the Youngstown test, with the difference that the test was continued until the barrel was so deeply burned that the contents were completely lost by leakage through seams and head, and the barrel when empty finally collapsed. Throughout this last test no internal pressures were registered. This test also developed the fact that the loaded "dunnage" (timber supporting racks), exposed for about 28 minute to a very severe fire, still had about a 50% unimpaired cross-section at the weakest point.

The Youngstown fire tests showed that extinguishment of a furiously burning barrel which is leaking is easily accomplished with a minimum of water. Leakage is automatically retarded or stopped through cooling effect of the water. Sound barrels will withstand fire for a considerable time before leakage occurs. The time element will be determined by the size and intensity of the fire, and the age, quality and condition of the barrels.

### Fire Test with "Yard Test Rack" at Youngstown.

A "yard test rack" was constructed to simulate the construction, arrangement and sprinkler spacing in the Peoria warehouses. The arrangement for the test is shown in Fig. 1. The barrels were new 50-gallon standard white oak, 8-hoop whiskey barrels. All were empty except the lowest center barrel, which contained a "whiskey proof" alcohol-water mixture.

To ignite barrels and rack a conical shaped pile of light and heavy wood, about 15 ft. in diameter at base and 5 ft. high, was placed close to the rack, slightly to windward, and ignited. As the fire gained headway the flames impinged on the ends and most of the circumference of the barrels, as well as one-half of the rack structure. Combustion, when once established, was intensified by the light wind prevailing.

After fifteen minutes the fire had reached an intense stage, with fifteen barrels and the portion of the rack containing them a mass of flames. The barrel containing the alcohol-water mixture started leaking freely. After twenty minutes water was turned on the six sprinklers and held at 22½ lbs. on lowest line C, 19 lbs. on middle line B, and 15 lbs. on top line A. Extinguishment was practically complete in about 20 seconds, the exception being a few remaining flickering flames at the bottom of the rack structure and barrel heads which ultimately went out.

This test showed that the barrels and rack do not ignite at all readily until exposed continuously to a very hot fire, and then do not propagate their own fire until a quite advanced stage of the fire is reached.

The test showed the ability of the six sprinklers at moderate pressures to furnish effective distribution and effect complete extinguishment in a very short time, even after the fire had progressed far beyond the point that it might

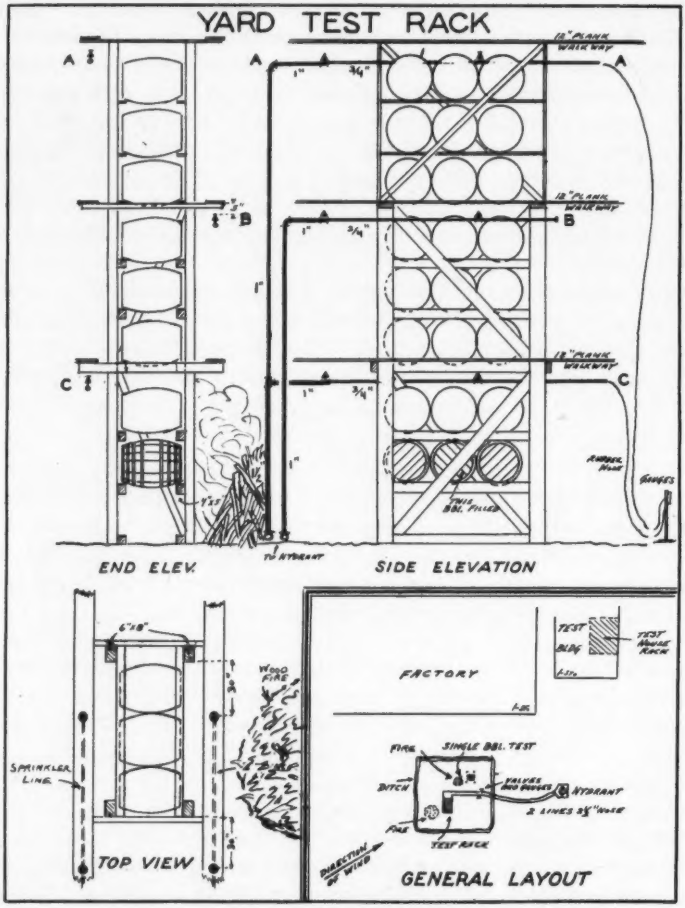


Fig. 1. Yard test rack.

be expected to progress in a warehouse in which sprinklers are automatic.

Sprinkler heads with fuses were not used, inasmuch as the thermal action that would be obtained under outdoor conditions would have been misleading. The fire was, therefore, allowed to progress to an advanced stage without hindrance of sprinklers.

### Tests at Peoria.

Common prudence prohibited the use of actual fire within an occupied whiskey rack warehouse, no matter how seemingly complete the fire equipment and control facilities might be. It was, therefore, decided to simulate as

**Fig. 2. Furnace used to supply hot air for warehouse tests.**

nearly as possible the heat phenomena incident to a fire and study the heated air current characteristics within the occupied warehouse under different test conditions.

A brick gas-fired furnace outside the warehouse, as shown in Fig. 2, was arranged to deliver hot air to the building through a 24 in. insulated metal duct. The outlet from this duct was directly under a barrel rack, as shown in Fig. 3, thus simulating the heat effect of a whiskey fire under the barrels. All parts of wood rack structure and the under sides of barrels immediately exposed to the high temperature air were protected with a covering of asbestos. A calorimeter type of continuous flammable vapor indicator was in place to determine the percentage of alcohol vapor present in the warehouse, and every precaution was taken to guard against the possibility of the start of an actual fire during the tests.

The sprinkler heads of the warehouse system were covered by paper bags to prevent their opening during the test, at the same time keeping them in operative condition in case an actual fire should develop. Attendants with first aid appliances and hose were continuously on duty during the tests.

To observe temperatures, 16 thermocouples were installed, controlled by switches at a central station for observation of tests, located on the second floor main aisle at a point directly opposite heat discharge head. (See Fig. 4.)

Pilot or test sprinklers (165° standard heads) were placed adjacent to and as close to the bag-covered sprinkler heads as was possible. Additional test sprinklers were also placed during some tests under catwalk planks midway between posts, as in Tests 6 and 7, and also were placed directly in the open space between catwalk plank and 4 in. by 5 in. dunnage piece, where they would be in direct path of the vertical heat travel. These various test

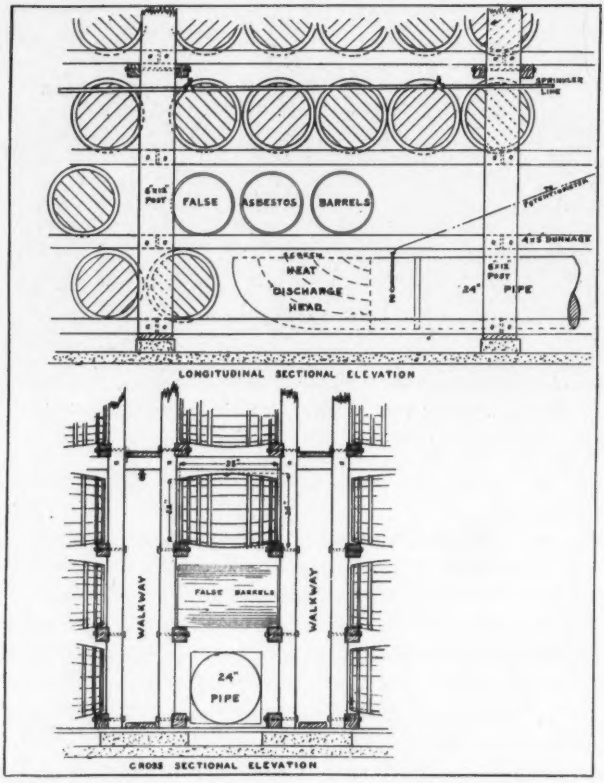


**Fig. 3. Section of interior of warehouse, showing arrangement of heat discharge head.**

sprinklers were intended to prove by actual operation the results that may be expected from sprinklers in service, as the recording of temperatures by the thermocouples might not be considered as conclusively proving actual operation of sprinklers.

Seven tests were conducted under varying conditions. The first three tests, simulating slow fires, did not develop temperatures sufficient to open sprinkler heads.

In test No. 4, 3110 cu. ft. of air per minute was delivered at a temperature of 882° F. Fig. 5 shows the log of this test, with the temperatures reached at the various thermocouples and the time of sprinkler operation. Because of the high temperatures used it was not considered safe to prolong this test for more than a few minutes; if it had been continued longer other sprinklers would doubtless have opened. The highest temperatures registered were

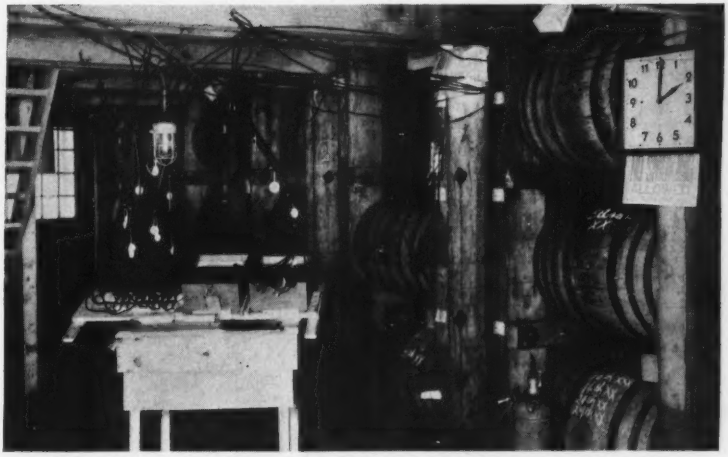

**Fig. 4. Recording instruments with wires leading to thermocouples.**

187° F. at thermocouple No. 4, and 182° F. at No. 6. The maximum temperature of 95° F. at thermocouples Nos. 11 and 12 indicated that comparatively little heat found its way to the adjacent walkways not directly over the hot air discharge opening.

Test No. 6 was made with same equipment as test No. 4. The position of the dummy barrels was slightly changed, with marked effect on the results obtained. The location of pilot sprinklers was slightly changed, and additional pilot sprinklers were placed under catwalk planks midway between posts, or in the center of the vertical bays.

The maximum delivery used was 3810 c.f.m. at 900° F. The approximate duration of test was about four minutes, with maximum temperatures at thermocouples Nos. 4, 6, 8 and 10 of 136°, 184°, 160° and 144° respectively. The chart of this test is shown in Fig. 6.

It will be noted by reference to test chart that pilot sprinklers E, F, G and H, midway between thermocouples Nos. 3-4 and 5-6, and 5 ft. and 13 ft. respectively above the heat outlet, all opened, while other devices at either side of the vertical bay did not operate, although wax coatings in these locations began flowing. Attention is called to the fusing of 165° solder type sprinklers located midway between thermocouples Nos. 3, 4, 5 and 6, all recording temperatures below the fusing point at the time pilot sprinklers E, F, G and H opened, showing that the upward passage of heat in the center of the vertical bay was confined to a narrow zone.

Test No. 7 was made with same equipment as test No. 6, except the addition of a deflector placed on top of the heat discharge head. This test

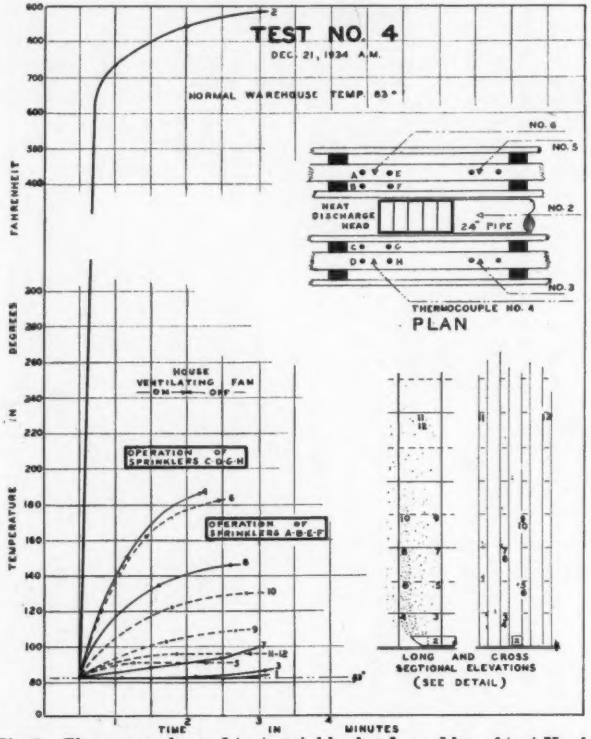


Fig. 5. Thermocouples and test sprinkler heads, and log of test No. 4.

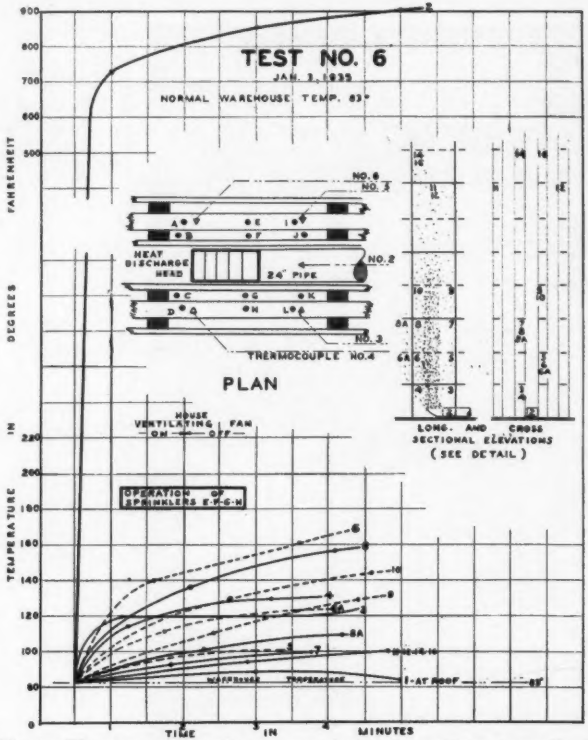


Fig. 6. Thermocouples and test sprinkler heads, and log of test No. 6.

was intended to develop the heat carrying characteristic of the vertical bays on the side where thermocouples Nos. 3, 5, 7 and 9 were located. Fig. 7 shows the arrangement of the equipment, and Fig. 8 the log of the test.

A maximum delivery of 3810 c.f.m. at 847° F. was used. The house ventilating fan was kept running. The duration of the test was about 2½ minutes.

The maximum temperatures registered at thermocouples Nos. 3, 5, 7 and 9 were 375°, 252°, 150° and 147°. All pilot sprinklers at thermocouples Nos. 3 and 5, 5 ft. and 13 ft. above the heat outlet, opened, with wax coating at Nos. 7 and 9 starting to flow.

Attention is called to the low temperatures recorded on thermocouples Nos. 4, 6, 8, 10, 14 and 16, all located on what in this test became the cold side of the vertical bay.

Roof temperatures showed no fluctuations, due partly to the ventilating fan maintaining gentle circulation and the shorter duration of test No. 7 as compared with test No. 6. The peculiar contour characteristics of the special heat deflector produced a marked concentration of heat on thermocouples Nos. 3 and 5, as compared with results on Nos. 4 and 6 in previous tests.

This test again demonstrated the sharp demarkation of the vertical heat zone, as pilot sprinklers removed only 2½ to 3 ft. from those operated were not affected.

## Conclusions.

An unfloored occupied whiskey rack warehouse has peculiar characteristics which, if fully understood and properly utilized, can be made to serve a very useful purpose in designing a sprinkler system capable of giving the maximum protection possible in an unfloored warehouse.

The distribution characteristics of water delivered from opened sprinkler heads, as the result of previous exhaustive tests, are now well known, and in evaluating the sprinkler protection of a properly equipped unfloored rack warehouse it will be seen that an actual advantage accrues from the fact that water delivered at any level, from the roof downward, on the barrels in storage and the rack holding them, performs its fire protection and extinguishment mission until it reaches the basement, or ground floor level. There it finally performs the very vital function of diluting and eventually extinguishing burning whiskey that may have escaped from the barrels.

The behavior of that heat liberated in floored structures has been quite definitely ascertained, and the banking of heat under ceilings in beam panels or channels determines the most effective location of sprinklers. The tests made at Peoria clearly indicate that an unfloored rack warehouse has in effect a series of such ceilings, but in vertical planes along which the heat banks and travels until it is either absorbed, diffused or reaches the roof.

If sprinklers are properly installed, spaced and located in the walkways forming the channels of these so-called vertical planes, they will intercept all

Fig. 5. Thermocouples and test sprinkler heads, and log of test No. 4. Fig. 6. Thermocouples and test sprinkler heads, and log of test No. 6.

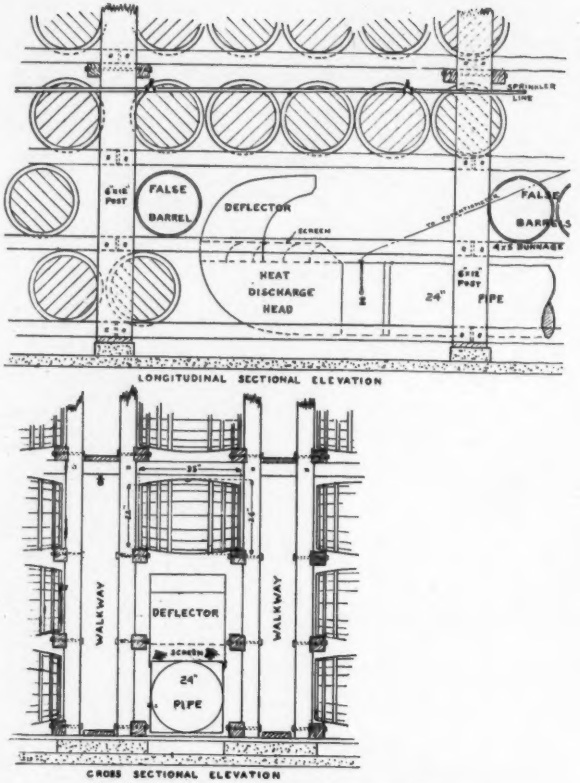


Fig. 7. Heat deflector used in test No. 7.

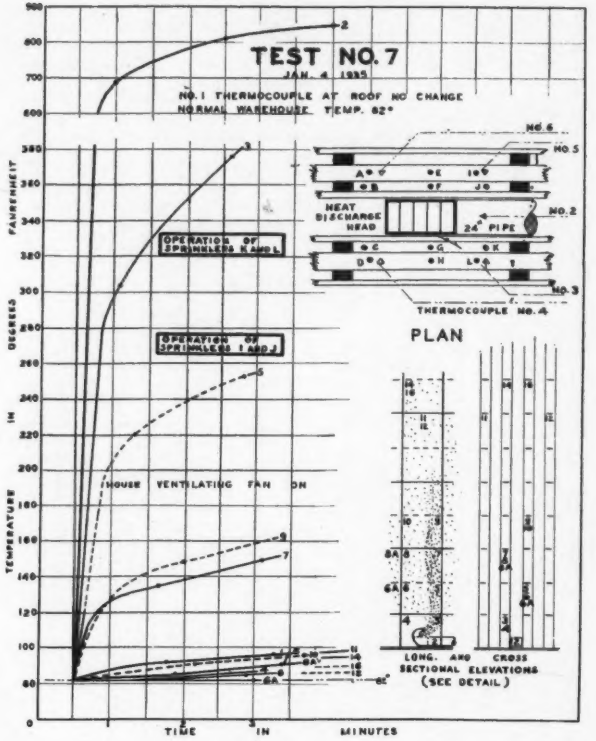


Fig. 8. Thermocouples and test sprinkler heads, and log of test No. 7.

the heat waves and bring into operation sprinkler heads as soon as operating temperatures are reached. The fact that the sprinklers next nearest the seat or origin of the fire may not be the first to operate is not vital so long as the heat wave or zone in its upward travel is eventually intercepted by sprinklers that do operate, for they will deliver the necessary water that will be continuously effective until the lowest floor, or the probable seat of the fire, is reached. The envelopment and cooling effect of water distributed from sprinklers, cumulative on the way downward, is a valuable asset not only in the extinguishment of the fire, but in stopping of leakage from barrels that may have been affected by the fire.

The slow-burning characteristics of the barrels and the rack structure, notably demonstrated in the preliminary tests, indicate that neither the structure nor its contents are favorable to a flash fire condition. The severest condition producing a sudden, rapid fire would be the breaking and simultaneous ignition of the whiskey from one or more barrels. The enormous heat evolved from such a fire would provide a setting most favorable for the prompt opening of all the sprinklers in the affected area. Such a fire would remain an alcohol fire for quite a few minutes, but would soon lose its potency because of the rapid dilution of the whiskey by water from the sprinklers. It would seem quite possible that in such a fire the burning whiskey would be extinguished before the fire attacked the barrels and structure itself.

The tests indicate that in the existing warehouses the heating and ventilating equipment does not perceptibly affect or retard the operation of sprinklers.

Another favorable characteristic of an unfloored warehouse, if properly equipped with sprinklers, is the tendency to prevent the horizontal spread and diffusion of heat and to prevent the banking of heat under the roof, either of which may, under certain conditions in floored structures, result in overtaxing a sprinkler system. The tendency of heat in an unfloored warehouse is to travel in narrow zones or strips in a vertical direction, resulting in the opening of a number of sprinklers on numerous branch lines in such a manner that no one branch line would be called upon for more than a part of its rated capacity, and the opened heads will, in consequence, enjoy an excess of branch line capacity.

The total maximum number of heads permissible on one riser is not so vital a limitation in an unfloored rack warehouse as in a floored warehouse, where the heat released on one floor may involve all the sprinklers on that floor in one fire. An open rack warehouse sprinkler system, if properly designed, would conform to the floored warehouse limitations of heads permitted in a given area without being subject to the mass opening of sprinkler heads possible in a floored warehouse, with but one exception, the possible shutting off of a sprinkler system for any reason. In the latter event, if the

Fig. 8. Thermocouples and test sprinkler heads, and log of test No. 7.

Fig. 7. Heat deflector used in test No. 7.

riser is not too seriously overloaded and the water supplies are of ample volume, complete extinguishment should still be possible with every head opened if the system is replaced in commission within a reasonable time after the fire starts.

In a large warehouse protected by a number of separate sprinkler systems, a skillfully designed sprinkler installation can be so arranged as to prevent complete impairment of protection even though a part of the sprinklers are shut off. If in any area selected sprinkler lines at given walkway levels, main aisleway lines, and roof lines are supplied by separate risers, the area will have considerable protection even though the main system supplying the area is shut off. Such an area temporarily without sprinkler protection would have the benefit of isolation by virtue of the neighboring systems still in service and the ultimate distribution of water from the roof sprinklers, and the segregated walkway levels, simultaneously supplied, that should hold the fire in check.

In unfloored rack warehouses with combustible walls this special design with subdivision of sprinkler systems should also provide for separate feed of all or a part of the sprinkler heads nearest the walls, to complete the isolation of the area in which sprinklers may be temporarily out of service.

With sprinkler systems designed about as outlined and provided with a powerful water supply of large volume available at high pressure as found in Peoria warehouses, dependable protection will have been provided to cope with average fire conditions. These fire fighting and extinguishing facilities will be as dependable as they can be made for large warehouses without positive horizontal and vertical fire subdivisions.

# Western High School Fire, Detroit.

On Monday evening, February 25, 1935, the main building of the Western High School at Detroit, Michigan, was almost completely destroyed with a loss estimated at more than half a million dollars. The building had been occupied until 11:00 P.M., and the fact that several fires broke out simultaneously at scattered points on the first floor indicates the possibility of incendiary origin. The difficulty of locating all of the individual fires before they had spread and the construction of the building, were contributing factors to the rapid spread of the fire and the consequent severity of the loss.

This property, like the Fitchburg, Mass., High School (QUARTERLY, Vol. 28, No. 3, January, 1935), was not insured, for the city has been a self-insurer for several years. It is estimated that the cost of replacement will be in the vicinity of thirty-eight cents per capita.

### Description of Building.

The Western High School building, with the exception of a new gymnasium of fire-resistive construction not involved in the fire, was constructed between the years 1898 and 1906. It was 145 by 287 feet in size, of ordinary brick-joisted construction, two and three stories in height and all one fire area. When the school was built, a three-foot space was left between the ceilings and floors above for ventilating ducts, these ducts also being installed in vertical partitions. This type of construction undoubtedly contributed materially to the spread of the fire.

### Story of the Fire.

The night janitor had just returned from the basement to the first floor when he detected smoke in the corridor. He endeavored to locate its source and finally saw flames at the end of a row of wooden lockers above what he first assumed to be an electric switch panel. He ran down the stairway to the basement and out through the rear of the building to his home, about one block from the school, from whence he called the fire department by telephone. This call was received at 11:52 P.M. A city fire alarm box was located inside the building within fifteen feet of where the janitor was standing when he discovered the fire, but in his excitement he forgot all about it.

Three engines, a ladder truck and a rescue squad responded to the alarm. The first engine company to arrive entered the building with a chemical line and first aid equipment, as there was no evidence of fire from the outside. They

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This report has been prepared from data furnished by Mr. Gordon C. Graham, Safety Engineer, Detroit Board of Education, and the Michigan Inspection Bureau (Member N.F.P.A.).

*Detroit Times Photo.*

**Ruins of Western High School, Detroit, showing ice-covered walls, all that remained after a fire of apparently incendiary origin swept the building. Ventilating ducts which honeycombed the building were a contributing factor in the spread of the fire to all parts of the structure.**

extinguished the blaze at the end of the row of lockers and discovered, meanwhile, another fire burning beneath a teacher's desk in a near-by classroom. While this latter incipient fire was being extinguished, two more similar fires were discovered under teachers' desks in adjoining classrooms. Another fire was then discovered at the far end of the corridor in a classroom at the extreme southeast corner of the building. This fire had apparently gained access to the ventilating ducts in the walls and had spread to the attic by the time it was located.

From this point on the fire gained rapid headway and a third alarm was sent in at 12:19 A.M. By the time the companies responding to this alarm reached the scene, the fire had involved the entire southeast corner of the building and was spreading rapidly, aided by the wind. An additional alarm was transmitted, bringing the total fire fighting forces on duty to eleven engine companies, four ladder companies and a rescue squad.

Shortly after 2 A.M. part of the roof fell in and the back wall on the east side toppled into the school building. A score of houses across a 25-foot alley, and directly south of the school, were ordered vacated because of the constant shower of sparks and brands which fell on the roof tops. The firemen drenched the roofs of these houses and, due to the cold, a layer of protective

ice soon formed which undoubtedly saved them from destruction. At about 2:30 A.M. the roof of the auditorium, which was located on the third floor, caved in and a section of the front wall fell outward, burying a number of hose lines which had been taken into the front entrance of the building. About this same time the chief of department ordered all his men from the building. There was little left of the school by 6 A.M. except portions of the first floor front and two or three classrooms of the south side.

While the fire was still burning, announcements were made in the newspapers and by radio directing the 1707 students at the school to report for classes at the Cass Technical High School on the day following the fire. The Cass Technical High School is located approximately three miles from the Western High School and, at the time of the fire, had an enrollment of 4092 students.

To accommodate the pupils from the Western High School, classes were moved forward and concentrated in the morning hours. The Western High School program was arranged to start at noon and continue until 4:45 P.M. The Western student group in this manner maintain their identity as a school within the Cass High School building, pending the erection of a new building. Obviously, this involves many sacrifices on the part of the teachers and students of both schools.

### Cause and Loss.

An examination of the building after the fire revealed the fact that the fire which the janitor thought he saw coming from above an electric switch panel was probably an open book which had been set on fire on top of a fire extinguisher. The half burned book was found buried in ice beneath the extinguisher in the corridor at the point where he first saw flames. The two or three classrooms in which incipient fires had been found were not destroyed, and the evidence of the separate fires in the three teachers' desks could be readily seen. An investigation is under way by the arson squad of the fire department. This is the third fire in schools in this city which showed evidence of incendiarism.

The loss was estimated at $582,700, of which approximately $97,300 was for equipment, some of which has been salvaged. This estimate is based on the cost of replacing the building with one similar in construction to that destroyed.

The school records, for the most part, were destroyed and in many instances it will be difficult, if not impossible, for the school authorities to forward proper credentials concerning students to colleges or universities that send in requests for scholarship information.

# Hotel Astor Fire, Milwaukee.

Report by Fire Insurance Rating Bureau (Wisconsin),
(Member N.F.P.A.).

Early in the morning of February 18, 1935, fire broke out in the basement of the Hotel Astor in Milwaukee, Wis., a nine-story building of fire-resistive construction, resulting in the loss of two lives. Several other occupants were overcome by smoke and required first aid treatment. The fire-resistive construction of the building and efficient fire fighting confined the fire to a relatively small area near the point of origin, with nominal property loss.

Exit facilities were adequate but not properly enclosed to prevent the spread of smoke, and with the failure of the electric lighting system early in the fire greater loss of life was prevented only by effective rescue work on the part of the fire department. The two persons who lost their lives were suffocated by smoke and gases which entered their apartment by means of a defective duct extending upward from the basement.

## Construction and Occupancy.

The hotel is a nine-story and basement building of fire-resistive construction, except for a combustible roof structure. Four stairways extend from the basement and/or lower floors to the eighth or ninth floors. These are enclosed by plastered hollow tile partitions with openings into corridors protected by swinging hollow metal doors, hung in pairs and having wired glass panels. There are also five open stairways, not cut off, leading from the basement to the floor above. One other stairway extends from the dining room rotunda on the first floor to the second floor corridor, enclosed in hollow tile partitions and having an ordinary wood panel type door on the second floor. All doors to stairways are equipped with mechanical door closers. To what extent the doors were closed at the time of the fire cannot be determined, but at least one of them has been found wedged open since the fire.

Other vertical openings consist of three elevator shafts, two passenger and one service, enclosed by hollow tile partitions with metal and wired glass doors extending from the basement to the ninth floor. A metal clothes chute also extends from the basement to the eighth floor, with openings at each floor with hinged wood doors.

The building is primarily occupied as an apartment hotel, with a small transient business.

## Fire Protection.

There were no night watchman, automatic sprinklers or automatic fire alarm. First aid protection in the form of hand extinguishers and a standpipe and hose system was provided but was not used in the fire. A public fire

*Milwaukee Journal Photo.*

**View of basement of Hotel Astor, Milwaukee, Wis., showing fire damage to tenants' storeroom. Smoke and gases generated from this fire, traveled up a pipe duct to an apartment on the fifth floor, where two persons were suffocated.**

alarm box is located at the corner just outside the hotel and seven hydrants and one fire cistern supplied by 8 and 12-inch mains assure ample water supply in case of fire.

### Story of the Fire.

The fire originated directly beneath the lobby in a small basement area used by tenants for the storage of personal belongings. It was discovered by the night clerk, who detected smoke entering his office from the basement through telephone ducts. He attempted to telephone the fire department, but found the system out of service so dispatched the night bell boy to send in an alarm from the street box outside the hotel. This alarm was received by the fire department at 3:59 A.M.

Three engine companies, one aerial truck, one city service truck, one company of the fire insurance patrol and a rescue squad responded to the first alarm in charge of an assistant chief. A second alarm was sounded at 4:16 A.M., to which three additional engine companies and one aerial truck company responded with the chief, deputy chief, and other officers. A second fire insurance patrol company also responded to this alarm. A third alarm was transmitted at 4:18 A.M., with three more engine companies, one city service truck and one water tower responding.

Upon arrival of the fire department most of the building was filled with smoke, which had penetrated to the lobby and upper floors through partially or wholly unprotected vertical openings. It was necessary to use gas masks to enter the basement. The building was ventilated at once and ladders were

placed on all sides at points best suited for rescue work. Seven hose lines were used, one of which supplied a distributing nozzle operated through a hole made in the lobby floor.

Fifty-eight firemen were engaged in rescue work and the inspection of rooms on the upper floors. Approximately forty occupants were taken down ladders from rooms as high as the sixth floor, and some two hundred were assisted down stairs. An inspection made directly after the fire showed all exits to be unobstructed, with doors in proper operating condition and that all occupants could have left the building by means of the regular exit facilities. The fact that some did not do so may be attributed to the fact that the hotel lights were out from virtually the start of the fire, and to the usual helplessness of some individuals in an emergency.

The actual fire was confined to an area in the basement approximately 40 by 150 feet. It was regarded as under control shortly after the arrival of the fire department, and the first companies were sent back to quarters about an hour after the first alarm was received. The exact cause of the fire was not determined. The loss was nominal, being largely due to smoke. There was practically no damage to vital structural parts of the building.

## Loss of Life.

The hotel has 144 apartments with from two to seven rooms each and 85 transient rooms, or a total of 956 rooms. It is estimated that there were approximately three hundred permanent tenants and two transients in the building at the time.

Two people died by suffocation. A deaf mute and his nurse occupied a fifth floor suite of two rooms, connecting through a bath. The smoke entered this apartment through a hole in broken plaster around soil and brine pipes, from a vertical duct which extended from the basement to the top story. Apparently this duct was not entirely sealed off at the lower end, and it acted as a flue, carrying the smoke and hot gases upward. It appears that the only outlet for escape of these gases was in the suite in question, in which the windows were closed. The nurse was found in her bed, and must have been overcome while asleep; the man apparently had awakened, as he was found on the bathroom floor. Artificial respiration was administered by the rescue squad but without effect.

Several other tenants were given first aid treatment, and some were removed to hospitals, but none was seriously affected.

# Sprinklers Avert Conflagration, Lynn, Mass.

Report by H. S. Walker.
(Engineer N.F.P.A.)

A seven-story sprinklered tenant manufacturing building was totally destroyed and five adjoining buildings were more or less severely damaged by a fire of undetermined origin in Lynn, Mass., on Wednesday, January 30, 1935. The fire started in the first floor of the tenant building where the sprinklers had been shut off for repairs, and within five minutes of discovery by a passer-by had involved the entire structure.

This fire indicates the potential hazard involved when a large area building with highly combustible contents is left for even a single night without sprinkler automatic fire alarm or watchman protection. An automatic fire alarm system as an auxiliary to the sprinklers would, in this case, have provided quick notification of the fire before it reached the proportions which it had when discovered.

This fire also clearly demonstrated the value of automatic sprinklers as protection against exposure fires. Three of the exposed buildings were sprinklered and this equipment was a major factor in preventing serious exposure losses.

## Property Involved.

The old Faunce and Spinney building in which the fire started was seven stories in height with basement, of plank and timber construction, and equipped throughout with automatic sprinklers. The elevator was well cut off and two stairways were poorly cut off. The building was in fair condition as to repairs. The care of fire protection equipment is said to have been indifferent.

The building, formerly a shoe factory, was partly occupied. Two floors were occupied for the manufacture of wood heels and two others were occupied for the covering of wood heels. The remainder of the building was vacant except for about fifty pounds of sheet pyroxylin and some baskets of uncovered wood heels in the basement and a small quantity of maple lumber on the first floor. Heat was furnished by an oil burner, the operation of which is said to have been satisfactory.

To the north of the building where the fire started was a five-story and basement brick-joisted factory occupied by three wood heel manufacturing concerns. This building was separated by an open space approximately ten feet wide with a cut-off bridge at the fifth floor level. Facing windows were equipped with shutters, but neither these nor the fire doors to the bridge leading to the burning building appear to have been closed. This building was

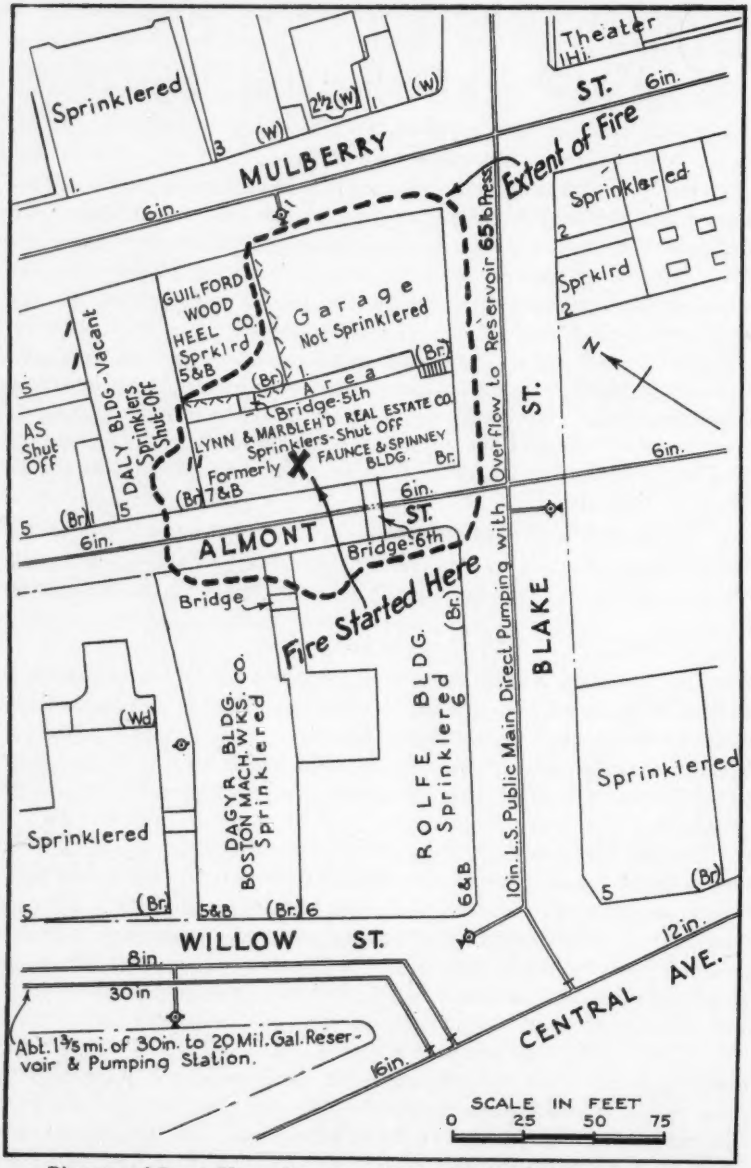



**Diagram of Lynn, Mass., fire area, showing location and private protection facilities of buildings involved in the fire of January 30, 1935. The value of automatic sprinklers as protection against exposure fire is clearly indicated.**

equipped throughout with automatic sprinklers in operating condition at the time of the fire.

At the rear was a group of vacant five-story brick-joisted factory buildings in which sprinkler protection has been withdrawn. A fire wall separated this group from the burning building, with openings on the fourth and fifth floors protected by sub-standard double fire doors.

Across Almont Street, 22 feet south of the fire, were two buildings of brick-joisted construction five and six stories in height. One, known as the Dagyr Building, was occupied by the Boston Machine Works Co. and the other, known as the Rolfe Building, was occupied by miscellaneous manufacturing establishments, mercantiles and offices. Both buildings were equipped with automatic sprinklers in operating condition.

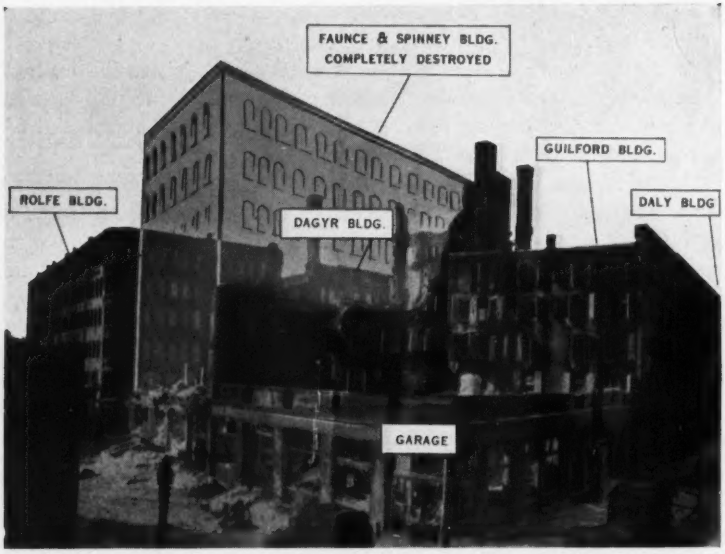
A one-story brick garage with wooden interior and roof adjoined the fire building on the north. This building was used for storage purposes. It was not sprinklered.

### Events Preceding the Fire.

At 2:56 A.M. on Tuesday morning, January 29, the fire department was called to the Faunce and Spinney building by an outsider who heard the sprinkler gong ringing. Firemen found a sprinkler operating on the first floor due to freezing. The building was cold. The sprinkler was replaced and the system restored to service. The firemen left the building after ejecting a man found sleeping in the first floor apparently under the influence of liquor. Again at 3:44 A.M., the same morning, the firemen were called to the building and this time found two sprinklers operating on the first floor and the system apparently frozen. The sprinkler system was shut off and drained, as the building was very cold. It is significant that the firemen found the building unlocked, a condition which is said to have existed for some time.

When daylight came, the fire department notified the representative of the owners, who engaged a local plumber to make the necessary repairs. Fourteen heads were replaced and considerable new piping was required. The plumber's crew were unable to complete their work during the day and left the property with the sprinkler system shut off for the night, a fact known to the owner's representative and to the fire department. Although it seems probable that the system might have been plugged on the first floor and protection restored to the upper floors, this was not done and no watchman was placed on the premises either by the owner or the fire department.

In addition to the engineer who left at about 10 P.M., it is understood that on the night of January 29 employees of the wood heel concern were in the building until about midnight. It is also stated that the man who had been found sleeping in the building the previous morning left a near-by café about 1 A.M. the morning of the fire, stating that he was going to the factory to sleep. He has not been seen since and may have been burned to death.




**The fire area, showing Faunce and Spinney building about as it appeared before the fire, and the other buildings involved.** (See also Frontispiece.)

## Story of the Fire.

The fire was discovered by a baker on his way to work. He states that when he first observed the fire, flames were evident in most of the windows of the first and second floors of the Faunce and Spinney building on the Almont Street side. He sent in an alarm without delay from a street box at 4:18 A.M. The firemen from the nearest fire station, approximately one-third of a mile distant, state that when they turned into Blake Street the building was well involved, with flames showing at practically every window on the Almont Street side up to, and including, the fifth floor. Within five minutes of the arrival of the first fire companies a hot air explosion occurred, blowing out all the windows in the building. One fireman was severely cut by flying glass.

A second alarm was transmitted at 4:25 A.M. followed by a general alarm, calling the remainder of the department, at 4:30 A.M. An attempt was made to reach the sprinkler valve located on the first floor of the burning building, but the headway of the fire made this impossible. The fire burned very rapidly and shortly before five o'clock the roof of the building failed, the water tank crashed through the floors below and the walls were forced out.

Twelve fire department pumpers (eight of 1000 g.p.m. capacity and four of 750 g.p.m. capacity) supplied approximately twenty-four hose lines, some of which were used as hand lines, while others supplied a deck gun on a hose

truck and three portable deluge guns. The water supply was adequate, and satisfactory pressures were maintained throughout the duration of the fire.

With factories adjoining on two sides and other buildings across a narrow street, heavy concentration of hose streams was required to control the fire. The deck gun, fed by five 2½-inch hose lines, was effectively used on the north side of the fire in Almont Street, forming a water curtain between the burning building and the Boston Machine Works and Rolfe Buildings. This gun was provided with a 2-inch nozzle. It was supplemented by two hand lines.

Other large size streams were furnished by three portable guns, each of which was supplied by three 2½-inch hose lines from pumpers. These were operated with 1½-inch nozzles. Hand lines were used from the street and from windows of the Rolfe Building where hose lines were used to supplement sprinklers in keeping the fire out of the building as well as to combat the fire in the building of origin. Many of the hand lines had 1⅛-inch or 1-inch nozzles, too small to be effective on a fire of this magnitude.

*International.*

**Powerful hose streams, supplemented by sprinklers in the exposed buildings, kept the fire from spreading across Almont Street, a narrow way only 22 feet wide.**

### Operation of Sprinklers.

Fortunately three of the five buildings directly exposed were equipped with automatic sprinklers. These sprinklers were not only an important factor in saving the exposed buildings from destruction but prevented the fire from reaching conflagration proportions. The Rolfe Building was in the direct path of the wind-driven flames, and the roof, cornice and window frames on the Almont Street side were soon involved. Forty-one sprinklers opened on the four upper floors, and with hose streams furnished by the fire department, held the fire from entering the building except on the top floor and roof.

The building of the Boston Machine Works, adjoining the Rolfe Building on the northwest, was not so severely exposed, and was better protected by the water curtain from the fire department's deck gun. Five sprinkler heads opened on the three upper floors and held the fire to the immediate vicinity of the windows. There was little fire damage other than a partly burned roof and burned out windows.

Fire entered the wood heel factory on Mulberry Street through windows at the rear, the shutters of which were not closed, and through open fire doors in the passageway from the burning building. Although a hose stream was directed on this building it could not be utilized with maximum effect, due to the location of the building, and automatic sprinklers alone may be credited with saving this property. The fire burned out the rear of the upper floors, but apparently reached but little of the pyroxylin stock in the building. Between the very considerable number of sprinkler heads that opened and the hose streams used by the fire department the entire contents of this building (very susceptible to water damage) were thoroughly soaked and with the fire damage the loss to contents was large.

### Other Exposure Fires.

The roof of the one-story garage at the corner of Mulberry and Blake Streets was, at the start of the fire, an excellent point from which to operate a hose stream. When the walls of the Faunce and Spinney building fell the firemen stationed on this roof narrowly escaped with their lives and several were injured when they jumped to the street below. The falling wall crashed through the roof, carrying fire with it, and the building was soon completely involved.

The unoccupied factory group in which the sprinklers had been turned off was connected with the building where the fire started by double fire doors, which apparently held. Fire entered, however, when the wall of the burning building crashed through the roof of this building to the fourth floor. This fire was extinguished by the stream from the deck gun on Almont Street and a hand line taken over an aerial ladder from Mulberry Street.

Burning brands were carried by the strong wind across the central part of the city, starting a number of small fires. These fires were extinguished by fire companies from neighboring cities and towns, responding under mutual aid agreements.

### Cause and Loss.

The cause of the fire is unknown. It may have been due to some careless act on the part of the man, now missing, who is believed to have been sleeping in the building. The loss is estimated to be in the vicinity of $200,000.

An interesting aftermath of the fire is a suit brought by the owner of the garage against the owners of the building where the fire started. It is alleged by the former that the sprinkler system of the Faunce and Spinney building was not in proper condition, thereby allowing the fire to get beyond control and spread to adjoining property.

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The photographs used in this article were furnished through the courtesy of the *Factory Mutual Record.*

# Savannah Waterfront Warehouse Fire.

The hazards incident to the storage and handling of large quantities of nitrate of soda and the difficulties of fighting a fire in properties where this material is present were emphasized on March 15, 1935, when a waterfront warehouse of the Central of Georgia Railway in Savannah, Georgia, was destroyed. Combustible construction, sub-standard fire walls and poorly protected openings permitted the fire to spread from the section where it started and quickly involve the entire structure. The estimated loss was $500,000.

## Property Involved.

The property involved in the fire was a warehouse one story high, 805 feet long and 250 feet wide, divided into four approximately equal sections by brick division walls. These sections were numbered 1, 2, 3 and 4, starting from the river end. It was built partly on piers and was of heavy creosoted timber construction, with wooden flooring on the wharf section and dirt floors in the warehouse portion. The roof was composition on heavy wood joists. Exterior walls were metal clad, except the east wall of the two sections nearest the river, which was brick. The west wall (along the slip) was open to the wharf deck.

There were three openings in each division wall protected by non-standard fire doors on each side of the wall. The center opening in each wall was unusually large, the doors being in two sections, closing toward the center of the building. Due to two railroad tracks which passed through these center openings, these doors did not fit flush with the floor. An open plank wharf communicated around the fire walls on the west or slip side. The walls were not properly teed at the ends.

The shed contained about 7700 tons of nitrate of soda nearly equally divided in all compartments, some ship loading gear and a small amount of miscellaneous cargo. Practically all of the nitrate of soda was in jute bags with paper lining, piled about eight bags high and well away from the walls. Aisleways were maintained.

Inside protection consisted of thirteen 2½-inch standpipes with hose attached, buckets, barrels and chemical extinguishers. Outside protection was furnished by the public fire department and a private fire brigade maintained by the railroad company. The railroad maintains its own private water supply and, while the supply and pressure appeared reasonably adequate during the fire, this protection with regard to the warehouse involved was poor, due to its somewhat inaccessible location. No fireboat was available and hydrants

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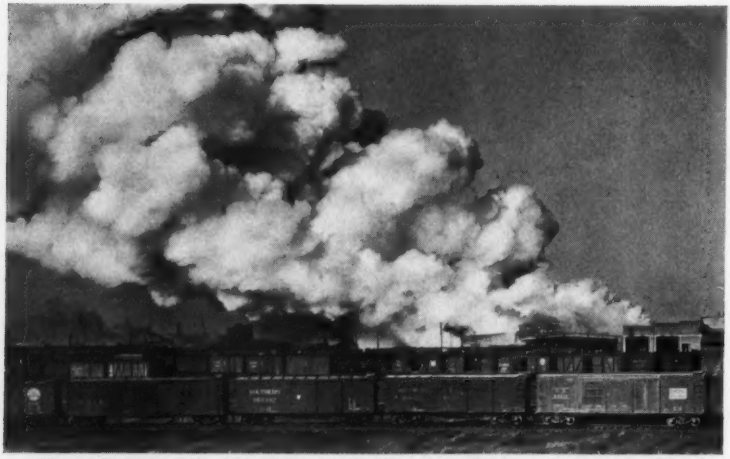
This report was prepared from data furnished by Mr. Charles W. Ehlers and the South-Eastern Underwriters Association (Members N.F.P.A.).



View of burning Central of Georgia Railroad warehouse at Savannah, Georgia, March 15, 1935. Note great volume of white smoke from nitrate of soda. This picture was taken within thirty minutes of the sounding of the first alarm.

were 900 feet and more from the river end of the shed where the fire started. An open slip on the west and a narrow 30-foot space occupied by railroad tracks and cars between the burning shed and the blank brick wall of a shed adjoining on the east made the handling of hose lines difficult.

The water supply for the property is provided by two gravity tanks in a 187-foot tower. One tank of 100,000 gallons capacity is at a 150-foot elevation and below it is a service tank of 60,000 gallons capacity elevated about 115 feet. The contents of both of these tanks are available for fire service with pressures of from 50 to 75 pounds. They are supplied by two electric pumps having a combined capacity of 50,000 gallons per day.

## Story of the Fire.

The temperature on the day of the fire was approximately 66° F. and relative humidity was about 50 per cent. A light breeze was blowing from the northeast. This breeze was less than the draft created by the fire.

No one was working in Section 1 nearest the river, where the fire was discovered, but a crew of negro laborers were bagging nitrate of soda in the section adjoining. One of these workmen and a watchman in the shed across the slip discovered the fire at about the same time and an alarm was turned in both from a local alarm station and a city fire alarm box, the latter about a third of a mile away. The first alarm was received at 4:00 P.M. and the private fire brigade and city fire department responded promptly, the latter reaching the scene of the fire at 4:03 P.M. Prior to the arrival of the city firemen, employees fought the fire with private equipment.

The first engine companies arriving stretched their hose lines to the section where the fire started. They found this section almost entirely involved, the nitrate of soda exploding and a tremendous amount of heat present. Nitrate of soda has been unloaded and stored in this property for years, and the flooring was impregnated with it. This condition, together with the creosoting of structural timber, accounts for the intensity of the fire.

The vertical fire doors at the western end of the fire wall between Sections 1 and 2 did not close, but one of them was released with an axe. The center horizontal doors did not operate. One vertical door on the east end did close automatically. The failure of the center doors was costly, for just inside Section 2 was a wooden freight car which immediately ignited. Along the eastern outside wall of the warehouse some of the fire doors operated but were destroyed and the fire extended to box cars on the siding and thence to the roof and later to doors in Section 2.

As the firemen retreated from Section 1 the seriousness of the situation became apparent. Approximately 50,000 square feet of shed area was a blazing inferno with about 5400 tons of nitrate remaining to be attacked and the fire rapidly gaining momentum. No fire boat was available, and the use of water in large quantities and at high pressure was impossible, due to the long hose lines required and limited pumping capacity. The fire was sweeping through the shed at seven different points: through the three openings in the fire wall (regardless of whether the sub-standard fire doors operated or not); on the east from box cars to roof; on the west by way of the wooden wharf deck and loading platform; under the wooden flooring of the wharf section; and over the low parapet of the fire wall on the roof.

The old steamship *City of Atlanta* was moored alongside the wharf and its superstructure was ignited from the intense heat given off by the fire. The ship was being used for dredging, with only a watchman aboard. As no steam was maintained the ship could not be moved under its own power and the fire fighting equipment aboard was useless. A tug boat, which had responded to the alarm, secured a line to the ship, although the intense heat and smoke made this very difficult, and pulled it out into the river, where the flames were extinguished by this and other tugs. Although the fire got below decks at one time, the principal damage was to the superstructure.

The firemen realized that the proper handling of a fire involving nitrate of soda necessitates the use of powerful streams, but lacking these there remained no choice but to keep water away from the nitrate as much as possible and to endeavor to reduce the heat generated as much as possible. The firemen were forced to retreat from one section to another, trying to hold the doors, although fire under the wharf and overhead on the roof had sometimes passed 150 feet beyond them. This created a particularly dangerous situation

at one point when fire traveling in this manner unexpectedly burst out at the doors leading to safety, flashed to nitrate near by, operated some of the fire doors and almost trapped several companies before they could drop their lines and flee. A company operating on the roof was similarly almost trapped by fire passing over the parapet.

At 4:20 P.M. the firemen had been driven from Section 2, although the adjoining Section 3 was still livable. From this point on, however, destruction was so rapid as to almost escape the eye. The nitrate soaked floors, timbers heavily impregnated with creosote, the heavy, slow-burning roof which confined the heat and the oxygen released by the sodium nitrate created a fire of unbelievable speed and intensity. The heat became unbearable within the sheds and at 4:30 P.M. every man was ordered from the building. At 4:35 P.M. (exactly 35 minutes after the first alarm) Section 4 was beginning to collapse, reducing to a mass of blazing débris approximately 200,000 square feet of area.

In the meantime, across the 235-foot slip the heat was intense, and burning embers were showering the wooden floors and the tar and gravel roof. Some idea of the radiated heat may be gained from the fact that in laying a line to protect the side of a shed across the slip the paint on a fire department pumper was blistered. Fire department and private hose streams were used to extinguish incipient blazes and cool the roof, with the result that although the entire wharf and shed smoked from one end to the other, actual outbursts of flames were quickly arrested.

### Cause and Loss.

The cause of the fire is not definitely known. The two most probable theories as to its origin seem to be spontaneous ignition of nitre bags or careless disposition of smoking material. Railroad officials state that strict orders had been given relative to the disposal of nitre bags and that all bags were removed at the end of each day's operations. No nitre had been handled in the section where the fire started for several days. It is, however, possible that some empty bags had been inadvertently left there or spontaneous ignition might have occurred in a bag containing soda.

The theory that smoking may have been the cause of the fire is also possible, in spite of the rigid enforcement of "no smoking" rules. Employees often "sneak a smoke" and it is possible that some laborer from the crew working in the next section had slipped into this section to smoke and dropped his cigarette butt on to a pile of nitre bags.

The loss has not been finally adjusted, but it is reported that this building was valued at approximately $250,000. About 7700 tons of nitrate of soda, valued at about $225,000, were destroyed, together with miscellaneous equipment and gear to the value of $5000. The damage to the superstructure of the *City of Atlanta* was considerable.

# Tacoma Grocery Co. Collapse and Fire.

**Report by Associated Reciprocal Exchanges.**
**(Member N.F.P.A.)**

A defective beam and excessive floor loads were responsible for the collapse of the upper stories and roof of the six-story plank on timber type warehouse building of the Tacoma Grocery Company in Tacoma, Washington, on October 19, 1934. Matches in cases, stored on an upper floor, were ignited by the collapse, setting fire to the débris and communicating to other parts of the building. The damage was considerable, as shown by the accompanying photograph.

The building was six stories in height, 75 feet wide and 120 feet deep, with floors of heavy plank on timber construction. The walls were of brick and the floors and roof were of slow-burning construction. Stairs were in a brick tower. The building was occupied as a wholesale grocery.

Fire protection consisted of a wet pipe sprinkler system supplied by a 15,000-gallon wooden gravity tank and a 10-inch city main with normal pressure of 80 pounds. Complete central station sprinkler supervisory service was supplied in lieu of a watchman.

## Story of the Collapse and Fire.

The first indication of anything wrong in the building was when the central station supervisory office received a water flow signal at 1:06 A.M. on Tuesday, October 9, 1934. This signal was transmitted to the fire department at 1:07 A.M. A fire alarm was received from a street box at 1:08 A.M., the box having been pulled by a passer-by who heard the alarm bell on the building ringing.

The fire department and two runners from the central station office arrived at the building together. The building was searched and it was found that two 1½-inch sprinkler pipes in the third story had been broken by the sagging of a floor beam. For some unknown reason the water was not shut off until 1:37 A.M., as indicated on the register at the central station office.

At 2 A.M., while firemen were clearing the floors of water, it was noticed that the floors adjoining the front wall were collapsing, and all rushed to the rear just in time to avoid injury. The collapse involved the roof for a distance of about 50 feet, the fourth, fifth and sixth floors for a distance of 20 feet, and the front brick wall for two-thirds of the width of the building above the third floor level, the wall falling into the street. A large quantity of the stock stored on the upper floors also slid into the street.

Matches in cases were stored near the front wall on the fifth floor and the collapse caused these to ignite. Part of them slid into the street and set

**Defective beams and excessive floor loads were responsible for the collapse of this Tacoma, Washington, grocery warehouse. Fire followed in the débris, seriously damaging the contents of the lower floors.**

fire to the mass of débris. The fire which continued on the fifth floor was quickly extinguished by the fire department using a water tower. The fire in the débris in the street became serious and before being extinguished communicated to the lower floors of the building.

The primary cause of the collapse was defective beams, heavy floor loads contributing. Continued absorption of water by stock caused excessive overloading in the vicinity of the already weakened floor and was immediately responsible for the collapse that followed, by creating undue pressure on either the longitudinal girder or the brick column of the brick wall, causing one or both to fail. This loss is indicative of what may happen when floors of a building are loaded beyond the safe limit.

# Fire Record of Oil Tank Ships.

Explosions and fires on oil tank ships have, during the past decade, served to direct the attention and efforts of operators, designers, builders and fire prevention experts toward the elimination of preventable hazards. The N.F.P.A. Committee on Marine Fire Hazards has developed regulations covering the freeing of oil tanks of flammable gases prior to entering or making repairs, and the Flammable Liquids Committee has developed regulations for Marine Oil Terminals. These general regulations have been supplemented by specific rules promulgated by individual operating companies for their own use, and by the American Petroleum Institute's Suggested Good Practice for Safe Loading and Discharging of Oil Tankers (1929).

While the knowledge of the hazards based on bitter experience and the enforcement of safe practice requirements have doubtless reduced the number of tanker accidents, the record is far from free of serious accidents. Some of the explosions and fires here recorded have been due to the violation or disregard of reasonable precautions, and in the majority of such cases the accident might have been avoided by observance of established recommendations and rules with respect to construction and equipment of vessels and operating procedure. A considerable number of fires involved oil barges and small tankers operated by independent shippers or operators who did not maintain the standard of equipment and operating procedure that has been characteristic of the larger oil companies that appreciate and recognize the importance of fire-safety measures. In some of the fires recorded, failure to comply with general requirements for the handling of flammable liquids was the primary factor in the fire, rather than any fault with the ship or equipment itself.

Failure of the human element is shown by the record to be a major factor in these fires. In many cases the individual or individuals responsible for the primary ignition died in the fire and the cause was reported as "undetermined." Where definite causes were stated in the reports, the predominating items were smoking aboard oil tank vessels, friction sparks from the careless handling of tools or metal objects, and the use of cutting or welding torches or hot rivets in the repair of tanks not properly freed of flammable gases.

The vessels involved in the fires included in this record varied from barges of a few thousand gallons capacity to tankers carrying more than 100,000 barrels. The record shows no direct relation between the seriousness of a tank ship fire and the carrying capacity, as some of the most serious losses involved barges of relatively small capacity.

The files of the Department of Fire Record of the National Fire Protection Association contain reports of fires on 78 ships or barges engaged in the

transportation of petroleum products which have occurred from 1916 to date. In order to present the fire experience of tank ship operation in logical relation to the potential hazards involved, this fire record has been divided into three sections: fires in transit (at sea, in harbors or rivers), fires during loading or unloading operations, and fires while tank ships were undergoing repairs in dry docks or elsewhere.

The record is by no means complete and does not include many small fires which occur from time to time in connection with the operation of tank ships and are extinguished by members of the tankers' crews or by private fire brigades of petroleum companies. Special reports furnished by N.F.P.A. members, records of the U. S. Steamboat Inspection Service, fire department records and reports based on newspaper accounts, which have been verified through the coöperation of N.F.P.A. members, are the source of data on the majority of the fires which make up this record.

## Character of Cargo.

Thirty, or approximately 38 per cent, of the ships involved in these fires were carrying cargoes of gasoline. Of the remainder, thirteen were laden with crude oil, three carried fuel oil in tanks, nineteen had empty tanks, and in thirteen instances the report was not clear as to the specific character of the cargo involved.

| | All Vessels | At Sea | In Harbors | Loading Unloading* | Under Repairs |
|---|---|---|---|---|---|
| Gasoline in bulk | 30 | 2 | 5 | 23 | 0 |
| Crude oil in bulk | 14 | 3 | 4 | 7 | 0 |
| Fuel oil in bulk | 4 | 0 | 2 | 2 | 0 |
| Oil, no data as to character | 14 | 3 | 8 | 3 | 0 |
| Tanks empty | 16 | 0 | 0 | 0 | 16 |
| Total | 78 | 8 | 19 | 35 | 16 |

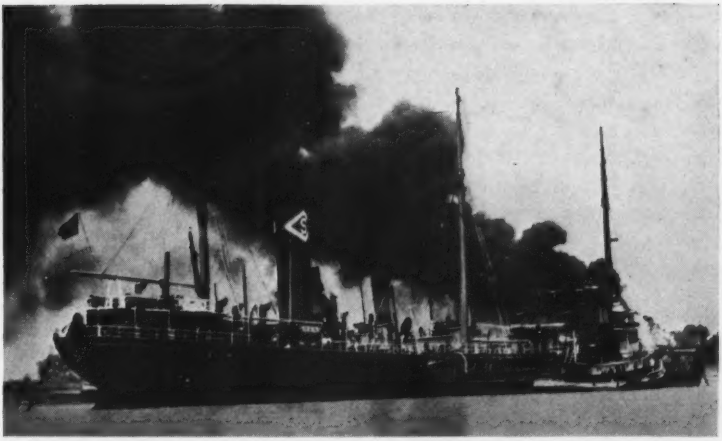
## Type of Ship.

The type of ship involved in the fires included forty-five steam or motor-driven tank ships and thirty-three oil or gasoline barges.

| | All Vessels | At Sea | In Harbors | Loading Unloading* | Under Repairs |
|---|---|---|---|---|---|
| Tank steamer or motorship | 45 | 8 | 9 | 14 | 14 |
| Oil barge | 33 | 0 | 10 | 21 | 2 |
| Total | 78 | 8 | 19 | 35 | 16 |

In view of the character of the original data, which include the larger and more important fires, but not a fair proportion of the smaller fires, this record may not be completely representative. The record does, however, include a sufficient number of fires to permit generalizations as to the usual

*Includes all fires occurring immediately prior to and after loading or unloading, as well as those occurring during actual loading and unloading operations.



*Acme.*

**Nine members of the crew lost their lives in the explosion and fire which ravaged this tanker in the Mississippi River at Good Hope, La., on July 15, 1932, after a cargo of gasoline had been taken aboard.**

causes of tank ship fires and accidents, and to indicate by specific example proper and adequate measures for their reduction.

## Fires Occurring in Transit.

Twenty-six fires involving twenty-seven vessels engaged in the transportation of petroleum products have been recorded while ships were at sea or operating in harbors or inland waterways. Seventeen tank steamers or motor ships and ten oil barges were involved in these fires. Seven fires occurred aboard craft used for the transportation of gasoline, seven were on crude oil carriers, two involved fuel oil tankers, and no data are available as to the character of the cargo carried in eleven instances. One fire (for statistical purposes recorded as two fires) involved both a crude oil carrier and a tanker laden with a full cargo of benzine.

Eight fires occurred at sea, all but two of which resulted in a total loss of ship and cargo. Of the two fires at sea which were successfully combated and extinguished by the ship's crew, in one case the damaged tanker reached port under its own power and in the other case the tanker was taken in tow by another ship. Of the fires occurring in harbors or inland waterways, nine resulted in approximately total loss, three fires following collisions resulted in moderate damage, and no data relative to the extent of damage were available in seven cases.

Fourteen fires involved loss of life or injury. One hundred and fifteen persons lost their lives in these fires, of whom eighty-seven were members of

crews operating tankers and twenty-eight were passengers or members of the crew of a passenger ship who were burned to death or drowned following a collision with a gasoline-laden tanker. Fifty-five injuries were reported, all to members of tanker crews. All but seven fires involving loss of life occurred on the high seas.

The table which follows indicates the reported cause of tank ship fires which have occurred while petroleum cargoes were in transit. The predominance of unknown causes is due to the fact that in many of these fires, particularly those at sea, the persons responsible either directly or indirectly for the fire perished in the flames.

### Causes of Fires in Transit.

| Cause | No. of Fires |
|---|---|
| Explosion—exact cause not determined | 9 |
| Fire following collision | 3* |
| Burning gasoline on water spread to barge | 2 |
| Back-fire of motor | 1 |
| Ignition of gasoline vapor from tugboat | 1 |
| Explosion—oil cook stove | 1 |
| Exposure—from burning barge | 1 |
| Smoking—matches | 1 |
| Unknown | 8 |
| Total | 27 |

### Typical Fires.

APRIL 8, 1926, MISSISSIPPI RIVER. When a tanker loaded with a cargo of benzine and a tanker carrying crude oil collided in the Mississippi River about 40 miles below New Orleans, fire followed. Considerable damage was sustained by the tanker carrying benzine, but the fire damage on the other tanker was confined principally to the paint locker, and was trivial.

The collision occurred at 8:30 P.M., at which time a light fog lay over the river. According to an investigation conducted by the U. S. Steamboat Inspection Service following the disaster, this fog was low lying, but high enough to conceal the hulls of the vessels so that the side lights were not visible to each other until the collision was inevitable. Mast-head lights, however, were visible above the fog bank. The inbound tanker was coming up river, keeping close to the east bank. The outbound tanker was presumably keeping to the middle of the river to take advantage of the current.

Testimony presented at the investigation revealed that the inbound tanker had pulled in toward the bank, the engine stopped and preparations were under way to anchor, when the outbound tanker loomed up through the fog dead ahead, coming at full speed. Signals were hastily exchanged between the ships and a desperate attempt was made to maneuver the ships in such a way as to avoid the impending collision. The maneuver failed, however, and

*Note: One of these fires involved two vessels.

**Twenty-five men lost their lives when these two tankers collided and took fire in the Mississippi River below New Orleans.**

the ships came together, the port side of the outbound tanker, about abreast the bridge, crashing on the bow of the other vessel.

The benzine cargo of the outbound tanker was released by the broaching of the shell plating by the collision and the impact was followed by a blinding flash of flame. Flaming benzine flowed on to the surface of the water and continued to burn. Ignition is thought to have come from sparks generated when the crash occurred.

The inbound tanker, able to navigate, pulled out of the fire zone following the collision and came to anchor. The fire on board was extinguished by the crew. The outbound tanker, out of control and on fire from stem to stern, was caught in the river current and carried eleven miles down the river. There was no loss of life on the inbound tanker, but twenty-five of the crew of fifty on the other tanker were burned to death or lost their lives when they jumped into the flaming river. (H-23197.)

JUNE 10, 1930, MASSACHUSETTS BAY. A few miles outside of Boston Harbor the steamship *Fairfax,* bound for Norfolk with a passenger list of seventy-one and a crew of seventy, rammed a tanker in a dense fog. Gasoline from the tanker's tanks covered the water and a flash of flame enveloped both vessels. The tanker sank within a few minutes and its entire crew of nineteen either went down with the vessel or were cremated by the fire burning on the water.

Considerable confusion resulted aboard the *Fairfax,* and in the excitement twenty-eight persons, passengers and members of the crew, jumped or were

thrown overboard only to perish in the flames. Other persons aboard the *Fairfax* were burned, some severely. The superstructure of the ship, ignited by the initial flash following the collision, burned for some time, but the fire was brought under control by the crew and the ship returned to Boston. After the first flash the flames subsided, but the fire continued to burn on the water for several days.

The report of the disaster made public by the U. S. Steamboat Inspection Service stated that at the time of the crash the *Fairfax* was proceeding at the rate of only three miles per hour, while the tanker was traveling at maximum speed. No one on the *Fairfax* heard any signal from the other ship until it loomed up in the fog ahead. (H-30031.)

MAY 8, 1931, ATLANTIC OCEAN. Fire of unknown origin broke out on a modern 2500-ton tank ship en route from Texas to Bayonne, N. J., with a cargo of crude oil, while about 250 miles south of Cape Hatteras. The fire was discovered by a member of the crew on watch, who saw smoke issuing from the forward hatch.

At the time of the fire the tanker was heading into the wind so was immediately hove to and fire fighting operations were commenced. When the hatch cover was removed there was a burst of fire, and a sudden shift of wind engulfed two members of the crew in flames. One of them was instantly killed and the other died later aboard a rescue vessel. An S O S call was sent out and another tanker reached the burning ship about three hours after the fire started. By this time the captain believed he could save his ship, but requested the rescue ship to take the injured man aboard and rush him to port for treatment.

Meanwhile the crew continued to fight the fire, and by maneuvering the ship so as to keep the wind always astern, the fire was confined to the forward hold. It was brought under control after two hours work. Although the water pumped into the forward hold caused the ship to ride down at the head and impeded its progress, the ship reached New York harbor under its own power. The fire caused but moderate structural damage. (H-32493.)

DECEMBER 29, 1932, ATLANTIC OCEAN. An oil tanker en route from Port Arthur, Texas, to Philadelphia with a cargo of crude oil, caught fire from an undetermined cause while 35 miles southeast of Frying Pan Shoals lightship, off the North Carolina coast. The fire was fought by the crew for two days, but on the morning of the 31st a violent explosion occurred and the ship sank soon after. The crew took to their boats and were picked up by another tanker and a coast guard cutter which came to their assistance.

According to press reports the tanker's radio power lines were destroyed at the outset of the fire and requests for assistance could not be broadcast. Another tanker plying the same route came upon the burning ship and stood by until a coast guard cutter reached the scene.

*International.*

**Airplane view of burning oil barge which took fire about five miles off Rockaway Beach, N. Y. The crew escaped without injury and were picked up by rescue vessels.**

The tanker was built in 1920 and was 3105 tons net. The value of the ship was approximately $450,000 and the cargo about $50,000. (H-36114.)

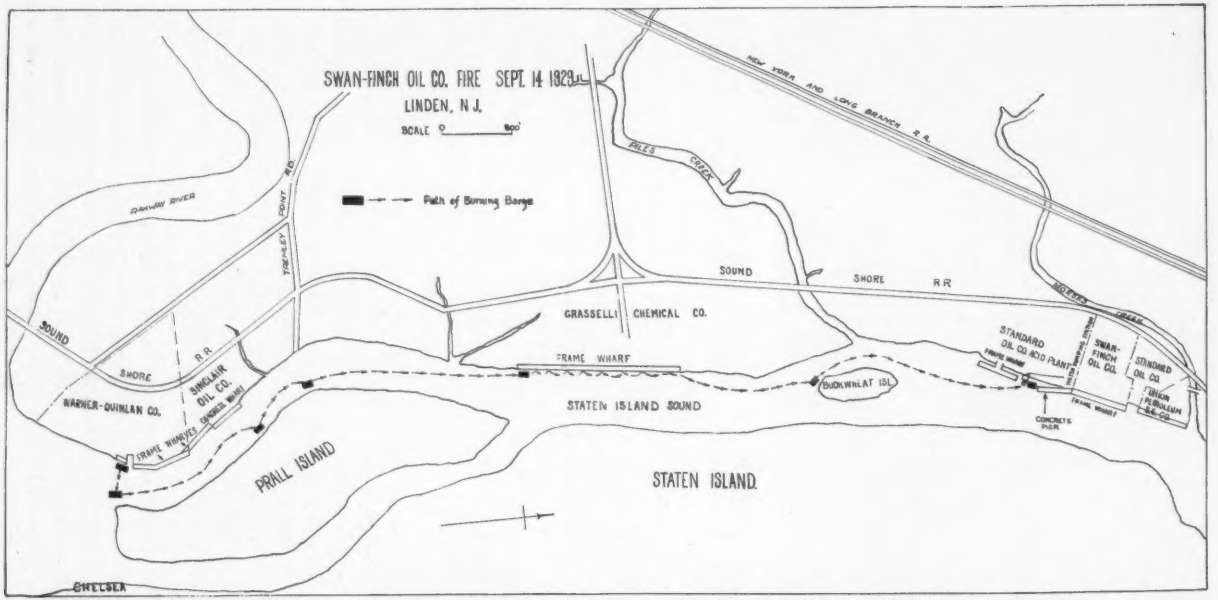
JULY 14, 1933, ATLANTIC OCEAN. While a tanker, en route from Port Arthur, Texas, to Warners, N. J., with a cargo of crude oil, was off Cape Fear, N. C., an explosion occurred in the after part of the vessel. The explosion, which took place at 9:30 A.M., ripped up the main plates of the deck and set fire to the ship and its cargo. One man was killed by the explosion and several others were injured. The radio was put out of commission at the start, and the smothering and fire lines were torn away.

The fire was fought all day without success, and at 8:15 P.M. all hands abandoned ship except the master and nine volunteers. Shortly thereafter two tank ships appeared and those remaining on the doomed vessel were taken off, except the master, who refused to leave. Just as the last survivors boarded one of the rescue ships the tanker sank, the master perishing with his ship.

The loss to the ship was estimated at $750,000, while the cargo was valued at approximately $100,000. (H-37104.)

## Fires Occurring While Loading or Unloading.

The greatest number of tank ship fires recorded in the N.F.P.A. fire record files occurred in connection with loading or unloading operations and while tankers or barges were tied up at petroleum companies' piers or wharves. Thirty-four fires, involving thirty-five vessels, are included in the record. Twenty of these fires were confined to the ship itself. Thirteen in-




**When an oil barge, which was awaiting unloading at the Warner-Quinlan Co. wharf on Staten Island Sound, was struck by lightning, it was cut loose and carried downstream with the wind and tide. Nine hours later, still afire, it crashed against a concrete pier more than two miles away. The burning oil, thus released, set fire to a near-by plant which was severely damaged. (See Quarterly, October, 1929, Vol. 23, No. 2, page 163.)**

volved the pier or other near-by structures, and one fire involved other ships in addition to the tanker itself.

Twenty-one of the vessels involved in these fires were tank barges and fourteen were tank steamers or motor tank ships. Gasoline cargoes were involved in twenty-three fires, crude oil or fuel oil in nine, and no data were available as to cargo in three fires.

The loss of life and injuries recorded for this group of fires, while greater in total than for fires at sea or in harbors and inland waters, was considerably less per fire. Forty-seven fires involved loss of life or injuries, with a total of ninety-two killed and seventy-five injured.

The causes of fires incidental to loading and unloading operations are covered in detail in the table which follows.

| Cause | | No. of Fires |
|---|---|---|
| Ignition of flammable vapors | | 14 |
| From fires under tugboat boilers | 2 | |
| From back-fire of barge or tugboat motor | 3 | |
| From open flame | 2 | |
| From galley stove | 1 | |
| From metallic spark | 1 | |
| From electric spark at pump room switch | 1 | |
| From static spark | 1 | |
| From unknown cause | 3 | |
| Explosion, exact cause undetermined | | 9 |
| Explosion or fire in pump room | | 3 |
| Lightning | | 2 |
| Discharge line broke. Oil ignited and fire spread to tanker | | 1 |
| Back-fire ignited leaking gasoline in engine room | | 1 |
| Gasoline overflowed to water, ignited and fire spread to barge | | 1 |
| Exposure | | 1 |
| Cause unknown | | 3 |
| Total | | 35 |

## Typical Fires.

APRIL 12, 1926, PORT ARTHUR, TEXAS. An explosion followed by fire wrecked a motor tank ship and cost the lives of twenty-five members of the crew. The disaster occurred at 2:30 A.M. while the last tank was being filled with gasoline. Sight holes were open on several of the tank hatches, including the one being filled, and the doors to the crew quarters in the poop were also open. The oil burning donkey boiler had one fire going.

The watch officer and two men were in charge of the tanks and connections on board, and a pier superintendent and assistants were watching the valves and lines on shore. Just prior to the explosion the watch officer left the deck, leaving instructions to be called if the level of the gasoline in the tank reached the bottom of the expansion trunk. He had been gone but a short

time when the pier superintendent shouted that the tank trunk was overflowing. They rushed to the dock valves and shut off the filling line, but not until a large quantity of gasoline had flowed over the after deck.

When the watch officer turned to board the ship he noticed the quartermaster writhing on the deck as though gassed, but before he could reach him the explosion occurred. The poop and crew quarters were wrecked and fire enveloped the entire after end of the vessel. Almost everyone aft was burned or injured, and of the crew of thirty-nine, twenty-five lost their lives. The fire was extinguished by the use of foam by the company's private fire brigade and the city fire department after members of the crew had gone on board under a water curtain and shut the open sight hatches.

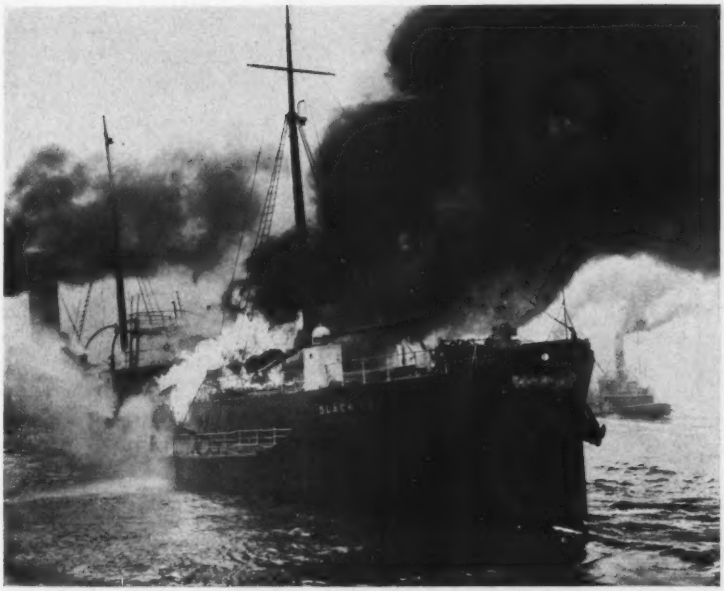
The men most likely to know the cause of the disaster were killed; but apparently the amount of slack in the tank was misjudged, and the quartermaster, watching too closely, became gassed and could not give the standby signal. Several possible causes of ignition were advanced, the most likely of which was that fumes from the overflow spread into the poop alleys and were there ignited by the donkey boiler or galley range fire. (H-23198.)

NOVEMBER 30, 1926, WILMINGTON, CAL. A tanker was loading gasoline when an explosion and fire occurred, resulting in the loss of four lives, injury to several others and damage of about $15,000 to the vessel.

Before loading operations commenced all fires on board were extinguished and filling lines were properly grounded. There was an electric service line connected to the ship to provide current for lights in the crew quarters. These lights were of ordinary type without guards or globes. The doors and port holes in the forward end of the crew quarters, which was under the poop, were open on to the deck.

The initial explosion occurred at 10:07 A.M. in the crew quarters while the deck officer was topping off No. 7 tank. Following the explosion a man with clothing aflame ran forward, igniting four main tanks and six summer tanks at the caps before he dropped. The explosion wrecked the poop, but fortunately the fire was confined to that portion of the vessel and to the ullage caps of the ignited tanks. The fire was extinguished by the private fire brigade of the plant, using foam streams which were played on the hatch covers and ullage plugs. This was successful only after blankets, wet with foam, had been stretched across the tank tops. The fire in the crew's quarters was extinguished by streams from a fireboat.

The cause of the explosion is thought to have been the ignition of gasoline fumes which penetrated the crew quarters through open doors and ports. The source of ignition was probably a cigarette left on a paper covered table. After the fire there was evidence that the paper had ignited and that a burning vapor train had passed through the space around the closed door which communicated with the companionway. Within the room itself there was practically



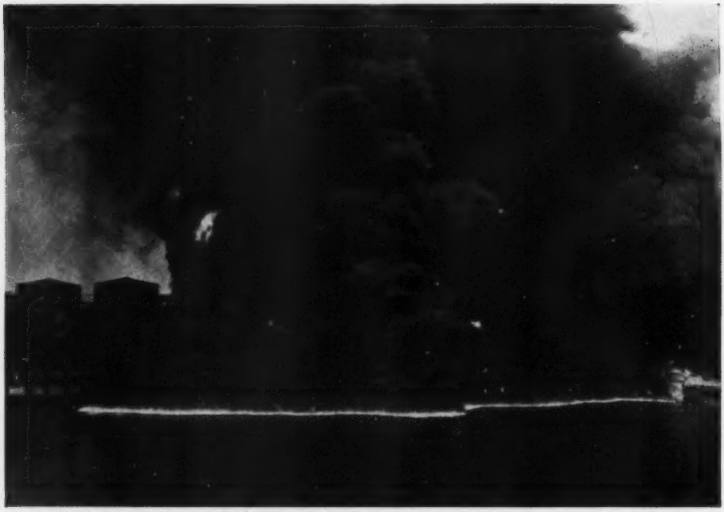
**Gasoline tanks on a tanker burning on Feb. 23, 1927, after an explosion which killed three men. The boat was tied up at a Bayonne, N. J., pier, but was towed out and beached on the Brooklyn flats. The fire was put out by fireboats.**

no damage. The cigarette ash and the charred paper were the only definite sources of ignition established by the inquiry, but smoking at some other point in the afterhouse was not improbable. (H-24176.)

FEBRUARY 23, 1927, BAYONNE, N. J. A tanker was loading when an explosion occurred amidships, igniting two tanks of gasoline and seriously damaging that portion of the vessel. The cargo consisted of naphtha in forward and after tanks, kerosene in next to after tank, and gasoline in the two amidships tanks. The kerosene and naphtha tanks did not catch fire.

Tugs towed the blazing ship from the loading pier to the Brooklyn flats, a maneuver much to their credit, for it appeared that the entire ship would be involved and additional explosions were likely. The fire was extinguished by fireboats, with a hull loss amounting to about $60,000. Three men were burned to death and several others were injured.

The indirect cause of this disaster was structural. The vessel was a "turret decker" with a center bridge and superstructure housing crew quarters and storerooms saddled over tanks Nos. 3 and 4 amidships. The turreted portion was practically an upper 'tween or shelter deck space, and under the floor of the midship accommodation was an air space open to this 'tween deck directly over the cargo tanks. Such a space is easily gassed and not easily



**Burning oil on the river at Buffalo, N. Y., July 27, 1928, following an explosion aboard an oil barge. Waterfront property for a considerable distance was badly damaged and one fire department pumper was destroyed.**

freed. The explosion took place in the port side of the bridge superstructure where the engineer's stores and lavatory were located. The bodies of the three who lost their lives were found there and knowledge of the specific cause of the explosion went with them. A forbidden light of some kind is a reasonable assumption of the probable cause. (H-24232.)

JULY 27, 1928, BUFFALO, N. Y. One fireman lost his life, twenty-eight others were injured and three ships were burned following an explosion on an oil barge in the Buffalo River. The fire burned seventeen hours.

The exact cause of the explosion was not determined. The barge had just been loaded with 5000 barrels of crude oil, and a steam tug was alongside. It is possible that flammable vapors seeping from the barge during the loading process were ignited from the boiler fires on the tug, or the explosion may have resulted from a static spark.

When the fire department reached the pier at 1:20 A.M. they found the fire on the opposite side of the river. Foam was not immediately available and hose streams brought into play were not effective. A foam generator was procured and two foam streams used, but with little effect. No water was poured into the hold containing the oil. It was decided to let the boat burn to the water's edge, although difficulty was anticipated when the boat sank.

There is but little current in the Buffalo River and for a time there was no danger, as the barge was well fastened with cables. About 11:00 A.M.,

however, the cables gave way and the barge drifted slowly upstream, first against docks of an oil company and then against an oil tanker. A line was attached to the tanker by the crew of a fireboat in order to move it to a safer position, but the tanker was grounded so that the attempt was unsuccessful. While at this task the burning barge came in contact with both the tanker and the fireboat. Tanks on the tanker were empty, but fumes were ignited and a severe explosion occurred. The fireboat was swept by fire and the crew was forced to jump into the river. The men were hampered by their heavy clothing and one fireman lost his life.

Wharves along the river front for several thousand feet were destroyed or damaged and a large refinery and several tank stations were menaced by the floating barge and burning oil on the river. A fire department pumping engine was destroyed when it was engulfed in flame and its operator was seriously burned in attempting to save it.

The barge continued to drift until it reached a railroad bridge, at which point cables had been stretched below the surface of the water to prevent the drifting craft from reaching the bridge. The barge sank at about 6:30 P.M., but oil continued to burn on the water for some time, being kept under control by hose streams.

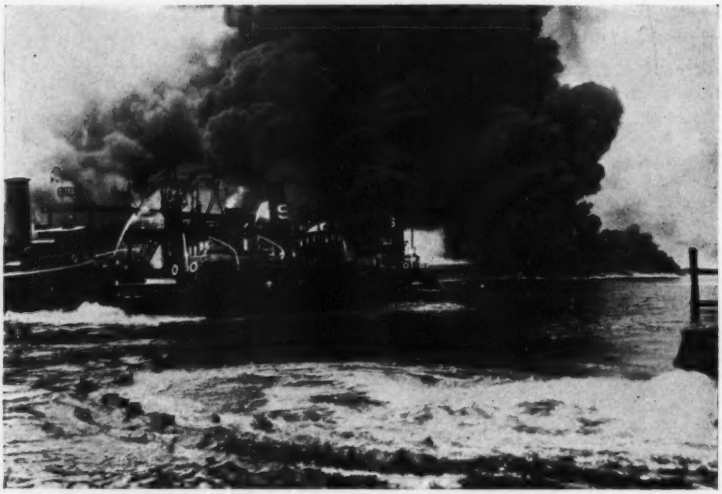
The loss was estimated at approximately $700,000, including the destruction of three boats and damage to docks on both sides of the river. (H-26478.)

AUGUST 7, 1928, LINDEN, N. J. Two men were burned and a motor oil barge was badly damaged when an explosion caused by the ignition of gasoline leaking from a broken feed pipe in the engine room wrecked the vessel. Unable to reach the seat of the fire with foam streams and fearing that the 4300 gallons of gasoline with which the barge was loaded would ignite and explode, the fire department used hose streams to sink it. The barge was later towed to shallow water by tugs and beached. (H-26615.)

AUGUST 9, 1929, BAYONNE, N. J. A tanker was discharging a cargo of crude oil when an explosion occurred in the pump room. The cause of the explosion was not definitely determined but was thought possibly to have been due to the ignition of flammable vapor by a mechanical spark. The blast destroyed the pump room amidships and wrecked part of the superstructure and deck. One man was instantly killed, another so badly burned that he died, and seven others were burned or otherwise injured.

Fire followed the explosion and the burning tanker was towed out into the bay, where the flames were extinguished by fireboats. The loss to the ship was estimated at $25,000. (H-28185.)

MAY 8, 1930, BAYONNE, N. J. Fire started by back-fire in the engine room of a motor driven tank barge destroyed the barge and seriously damaged the terminal and oil refinery of an oil refining company with a loss estimated in the vicinity of $2,000,000.



**Blazing oil tanks and piers at Bayonne, N. J., following an explosion aboard a motor tank barge loaded with gasoline. The aggregate loss was estimated in excess of $2,000,000.**

The tank barge, of 9000 gallons capacity, had just been filled with a cargo, one-half of which was high test gasoline and the other half ordinary gasoline. All proper precautions in loading had apparently been observed and the boat prepared to cast off. When the engine was started an explosion occurred, presumably from a back-fire which ignited some gasoline vapor, rupturing the tanks and scattering burning gasoline over a wide area.

Before the resultant fire was brought under control it had destroyed three piers, a barrel house, eighteen tanks with about 5,000,000 gallons of gasoline and fuel oil, a power house, pump houses and several other structures. Three men were seriously hurt. (H-29524.)

JUNE 13, 1931, SEWAREN, N. J. Two barges, laden with 15,000 gallons of gasoline, a tugboat and part of a 485-foot wharf were destroyed when gasoline, which had overflowed on the surface of the water during filling operations, ignited. The fire occurred just as filling operations were completed. There was a sudden crackling and the oily film on the water ignited, quickly followed by a flash which enveloped the tug and the near-by barge. The fire spread rapidly, involved another barge and the pier near by.

The source of ignition was not definitely determined, but may have been from the fires under the tugboat's boilers. The loss to the motor propelled barge was estimated at $50,000, with about $15,000 loss to cargo. The loss to the other barge was approximately $20,000, with $10,000 loss to the cargo. The damage to the tug and the wharf was not ascertained. (H-32627.)

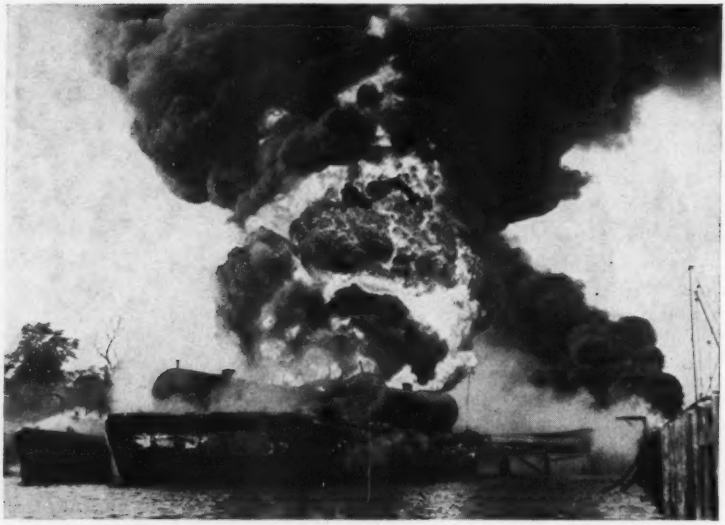
**Firemen extinguishing fire on a gasoline tanker at San Francisco on Nov. 20, 1931. That the fire did not have more disastrous effects was due to the concentration of hose streams at close range by the fire department.**

NOVEMBER 20, 1931, SAN FRANCISCO, CAL. Four men lost their lives as the result of an explosion and fire while a tanker was unloading a cargo consisting of 265,000 gallons of gasoline. That the fire did not have more disastrous results was attributed to effective fire fighting on the part of the city fire department.

The initial explosion occurred shortly before noon, when most of the crew were in the mess room, and followed the bursting of the discharge hose from the tanker to the manifold on shore, which allowed the gasoline to flow over the decks. The pumps were stopped almost immediately and an attempt was made to operate the shut-off valves, but before any action could be taken the explosion took place. The pump man ashore was severely burned by the blast, and the two men on deck were burned to death when their oil soaked clothing was ignited. As the crew rushed for exits, a second explosion shook the ship, injuring a number of them. Of these, one lost his life, the body being recovered from the bay later.

The exact cause of the break in the hose line was not definitely determined. The theory as to the source of ignition is that gasoline vapor found its way into the ventilation ducts and that when the officers of the ship saw the gasoline flowing on the deck and ordered the pump shut down, the throwing of the switches produced an electric spark which ignited the vapor, causing an explosion in the deck house.

The superstructure of the ship was all ablaze when the fire department arrived. The fire was fought at close range with hose streams and was soon



*Acme.*

**Burning gasoline tank barges at Sewaren, N. J., June 13, 1931. Gasoline which had overflowed on to the water during loading operations ignited and the resultant fire destroyed two tank barges, a tug boat and part of the near-by pier. The property damage amounted to approximately $100,000.**

extinguished. Water was thoroughly circulated over the tanks so that their temperatures were kept down. This procedure, while obviously involving some risk to life, prevented the possibility of a much greater explosion and additional losses to life and property.

The fire spread to the wharf and ignited timbers beneath the pier deck. Firemen operating from small boats extinguished these secondary fires and confined the damage to the pier to not exceeding $500. The damage to the ship was considerable. (H-34200.)

JULY 15, 1932, GOOD HOPE, LA. An explosion occurred at 6:05 A.M. aboard a tank steamer which had just taken on a cargo of approximately 40,000 barrels of gasoline and naphtha. The initial explosion appears to have originated in the vicinity of the crew's quarters in the forecastle and was followed by two secondary blasts. Fire followed immediately in the forward deep tank, located under the crew's quarters, and in the pump room directly aft of this tank. Nine men lost their lives, four being trapped in their bunks or on top of the forecastle, and five dying later in hospitals.

The cause of the fire is not known. When the initial explosion occurred an oil inspector was taking the soundings of the No. 1 main tank and the shore man was disconnecting the gasoline hose. Both lost their lives. The explosion ruptured all steam smothering lines to the tanks involved. Hatch

covers were blown clear of the hatches on the forward deep tank and the pump room. One of the explosions caused a leakage of gasoline through the bulkhead in three places from the forward deep tank into the pump room and, in addition, caused leaks from two wing tanks located above the pump room floor. Leaks also developed in the No. 1 main tank directly aft of the pump room, permitting gasoline to flow across the main deck. The fire involved the forward deep tank, the pump room, No. 1 main tank, and spread to the bridge forecastle and captain's quarters.

Shortly after the fire started, a fireboat was summoned from New Orleans. During the entire day this boat, assisted by several tugs, pumped water on to the hull and deck plates, keeping them cool. The burning ship was towed to the opposite side of the river and beached. In spite of the efforts made to extinguish the fire it continued to burn for the better part of two days. It was finally extinguished by the use of foam.

The total damage from the explosion and fire was estimated as follows: tanker $130,000, cargo $15,000, dock property $5000, a total of $150,000. (H-35652.)

## Fires Occurring During Repairs.

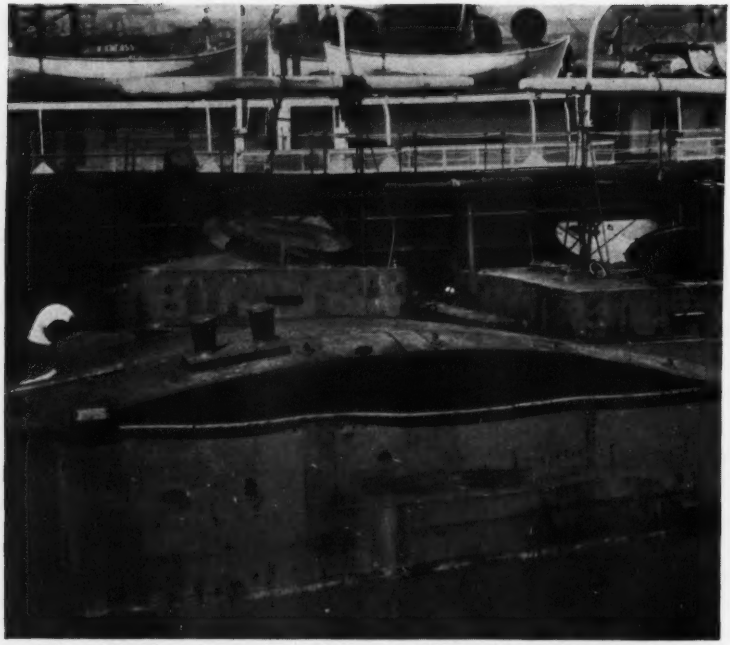
Sixteen tanker fires occurring while the vessels were undergoing repairs have been recorded, and while the number of such fires is less than those which have occurred under other conditions, these fires have been attended with severe loss of life and injuries. There was loss of life in eleven of these fires, the number killed being 99. In the same number of fires a total of 217 men are known to have been injured. Fourteen of the vessels involved were tankers and two were barges.

In all but two instances fires originated in empty tanks. The two exceptions were a fire starting between the ship and the dock, and a fire occurring in one of several storage tanks of a floating dry dock to which the cargo of the tanker had been transferred while the vessel was therein. In three instances the tanks had been tested and appeared to be gas free, one fire occurred while the tank was being steamed out, and in eight fires the tanks had not been tested and contained gas. In four cases the condition of the tanks was not reported.

The causes of these fires are listed in the following table:

**Causes of Fires Occurring During Repairs.**

| | No. of Fires |
|---|---|
| Vapor in empty tank ignited—exact cause undetermined | 6 |
| Vapor ignited by acetylene torch | 5 |
| Vapor ignited by careless smoking | 3 |
| Vapor from gasoline flowing on dock ignited | 1 |
| Vapor ignited in dry dock by hot rivet | 1 |
| Total | 16 |



**The results of a vapor explosion in a supposedly empty ship's tank. Thorough cleaning of gasoline and oil tanks, followed by tests of the atmosphere in the tank prior to entering for making repairs, should prevent accidents like this.**

## Typical Fires.

APRIL 8, 1926, NEW ORLEANS, LA. A tanker, undergoing repairs in dry dock, was wrecked amidships and aft when an explosion followed a fire which broke out on the dry dock. Eight men were killed and forty were injured.

Prior to arriving at the repair yard the tanks had been steamed, and when the vessel was docked a labor gang was sent aboard to wash down the tanks, and a machinist gang started stripping down in the engine room. The washing was continued after the tanks came dry until all tanks were finished, except two of the cofferdams, which still contained considerable oil or gasoline. The washing was done from deck through the hatches and it was impossible to reach the upper parts of the tanks in the wings of the vessel.

In the meantime, work in the engine room and pump room was proceeding. Boilermakers were removing the bleeder plugs from the bottom of the vessel to drain tanks, a machinist gang had started to remove the propeller, and a gang of laborers had started to clean the ship's bottom.

It is certain that up to the time of the fire no test had been made of tanks for gas content, and it appears also equally clear that the tanks were still very

gassy during and after the washdown. Much gasoline was mixed with the flow on to the dock from the bleeders, and a special watch was detailed by the yard, presumably on account of the foul condition of the vessel and dock.

About three hours after the vessel came dry a flash of flame burst out on the starboard side of the vessel, apparently from between the ship and the wing of the dock. It spread to the port side and blew aft and over the deck for about a minute. Then a series of several explosions followed at close intervals which wrecked the ship and was responsible for the loss of life.

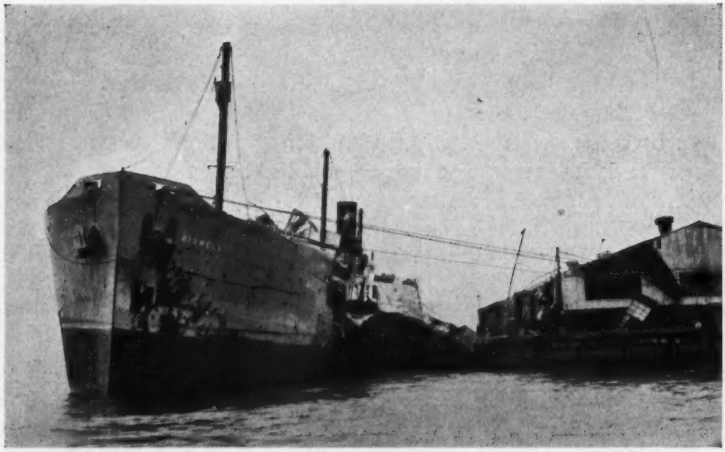
The cause of the fire was not ascertained, but it appears likely that the fumes from gasoline flowing on to the dock came in contact with a spark or open flame. The fire spread aft on the dry dock and water, and set fire to a river steamer just astern of the dry dock. (H-23197.)

JUNE 14, 1926, SAN FRANCISCO, CALIF. A tanker was in dry dock for cleaning and blow down. No hot work was contemplated and all cargo tanks were, therefore, closed off from other tanks and battened down, although not gas freed. The chain locker and between decks over the fore deep tank had been ventilated. All operations had been conducted in uniformity with the regulations governing marine fire hazards of the N.F.P.A. The ship was equipped with a steam smothering line system, through which all cargo tanks, cofferdams, between decks and fore deep tank were interconnected.

At the dry dock a few keel rivets in the fore deep tank were found leaking. A dock hose was run through the ullage hole of this tank and water turned on preparatory to calking and welding the loose rivets from the outside, but it is thought neither of these latter operations had commenced. The fore deep tank was vented through two screened vents terminating about four feet above the deck. The tank had contained only heavy fuel oil and the water was being placed in it purely as an extreme precautionary measure. The vessel was completely cold, no power of any kind being on board.

About three hours after the vessel came dry a violent explosion occurred in the fore deep tank, which wrecked the entire forward part of the vessel. No fire ensued, but three men were injured by falling from stagings which were hung overside. Investigation developed that gas had been communicated to the fore deep tank from the cargo tanks through the steam smothering line system. Cargo tanks and a cofferdam separating them from the forward portion of the vessel were not involved in the explosion. The source of ignition was not determined. (H-35569.)

NOVEMBER 19, 1926, SPARROWS POINT, MD. A series of explosions on an oil tanker while in dry dock just beyond the city limits of Baltimore wrecked the vessel and was responsible for the loss of at least eighteen lives and injury to seventy men. The ship had discharged a cargo of crude oil the day previous to the explosion and had then been taken to dry dock. It is not known whether the tanks had been steamed and gas freed before docking.



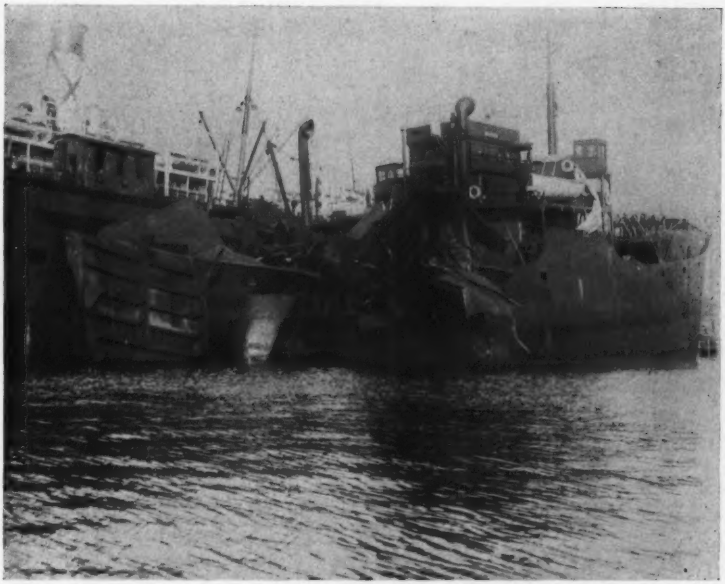
**The explosion which ripped this tanker asunder amidships at Marcus Hook, Pa., on Feb. 4, 1932, may have been due to a static spark generated while cleaning tanks. Of the twenty persons who were in the midship section, only two escaped. (See Quarterly, April, 1932, Vol. 25, No. 4, page 390.)**

The first explosion occurred at 11:00 A.M. while workmen and members of the crew were going over the ship. It was followed by several other lesser explosions, followed by an outburst of flame which involved eight of the sixteen oil tanks on the vessel. The force of the explosion, which was centered amidships, blew out the sides of the vessel, ripped away the steel deck plates, and hurled pieces of heavy equipment several hundred feet. One piece of metal weighing more than twenty tons was thrown a distance of more than 200 feet to an adjoining dock.

A call was sent to the Baltimore Fire Department, which responded promptly with a fireboat and foam equipment. About 30,000 gallons of foam were used, and the fire was brought under control without involving the other eight tanks.

The cause of the explosion is rather indefinite. It may have occurred from any one of the three following causes: (1) the attempt to light a cigarette near one of the tank hatches, which were being painted by members of the crew and in which the sight holes may have been open, (2) the contact of flammable vapors with either of two electric welders being used by shipyard forces (one of them on deck), (3) the contact of flammable vapors with acetylene torches or other equipment used in repair work on rivets on the starboard side of the ship. (H-24001.)

DECEMBER 11, 1926, BROOKLYN, N. Y. A tanker arrived at New York December 7, discharged a cargo of crude oil to lighters and then steamed and washed tanks. On December 10 the vessel proceeded to dry dock for cleaning



**The wreckage of a tanker in Erie Basin, Brooklyn, N. Y., after the explosion of a tank from which a cargo of light crude oil had just been discharged.**

and painting bottom. This work was completed December 11 and the vessel was tied up to a yard pier.

While the outside repairs were being made it was also proposed to stop a small leak from No. 4 cargo tank to the pump room which was between tanks No. 4 and No. 5. Tank No. 4 had had a second steaming and had been pronounced gas free, but work had not commenced on it. The hatches on all tanks with the exception of No. 4 were closed, but ullage caps were open. Oil was being run back by gravity from tanks No. 1 and No. 2 to tank No. 5 in order to get propeller immersion prior to leaving the next day. The whole ship with the exception of tank No. 4 was known to be gassy.

This was the condition at 5:50 P.M., when an explosion occurred in the pump room or tank No. 5. It was immediately followed by other more intense explosions which wrecked the whole after well of the vessel. Fire in the wrecked tanks followed, but was quickly extinguished or burned out.

No deaths resulted due to the quick action of a tugboat captain, who came alongside and took off the crew of twenty-seven before the more serious explosion occurred. The cause of the explosion is unknown. The damage was reported as $475,000. (H-24177.)

AUGUST 3, 1929, KOSMOSDALE, KY. An explosion wrecked a 170-foot steel tank barge, killing seven members of a repair crew who were burning off

**Firemen playing hose streams on the wreckage of a tanker and dry dock at Montreal after the explosion which cost the lives of twenty-six workmen and four firemen.**

paint. Oil had been pumped out to within two inches of the bottom of the tank. Fumes in the tank were ignited by an acetylene torch used by workmen. (H-30011.)

JUNE 17, 1932, MONTREAL, P. Q. A floating dry dock was the scene of several explosions and a fire in which thirty men lost their lives and many more were severely injured. Among those killed were four members of the Montreal Fire Department, including the chief.

The explosions occurred while an oil tanker was undergoing repairs and replacements to the steel plates in her hull as the result of going aground. The oil from the vessel's damaged tanks had been removed and placed in thirteen of the ballast tanks in the steel walls and floor of the dry dock. The tanker had been steamed out and tested gas free.

The initial explosion occurred about 3:30 A.M. while a night crew of approximately 100 workers were rushing repairs. Two of the tanks in the bottom of the dry dock let go almost simultaneously and a shower of blazing oil was thrown over the dry dock and tanker. Workmen on the dock and in the hold of the vessel, their clothing aflame, struggled to escape. Some succeeded in reaching undamaged portions, some plunged into the water alongside, while others were burned to death where they stood. Members of the tanker crew, numbering over thirty, were thrown from their bunks in the forecastle by the explosion but made their escape.

About an hour after the first explosion, while the fire chief and some of his men were standing on the wall of the dry dock directing streams on the tanker, which had caught fire in the bridge structure and the officers' quarters, another severe explosion took place in one of the side tanks directly under

where the firemen were standing, causing their deaths. This explosion was undoubtedly the result of oil vapor in the tank becoming ignited from the fire in progress and was one of five tanks to burst in this manner. No explosions occurred on board the tanker, but fire communicated to the vessel through the space where plates had been removed.

The cause of the disaster was obviously an explosion of vapor in the tanks of the dry dock. The most logical cause of ignition suggested seems to be that heat from the portable forges and acetylene torches used in riveting the plates caused gases to expand in the tanks containing the waste oil. This vapor, escaping possibly through a leaking seam on the dry dock floor, was ignited by the lighted forge. The vents from the tanks were too far distant to have been responsible for the escaping vapor. (H-35837.)

JUNE 7, 1934, PHILADELPHIA, PA. Three workmen were killed and twenty-six others were injured in an explosion aboard a tanker which was in dry dock for hull repairs. Preparatory to coming to the dry dock all tanks had been steamed out and washed down twice. Tests had been made and the tanks had been certified as gas free. Workmen, using acetylene torches, had removed a large number of the rivets holding the bow plates when the explosion occurred. It is remarkable that there were not more fatalities.

The explosion was attributed to ignition of vapor in the vessel by an acetylene torch. The vapor may have accumulated in a water storage tank in the bow due to a leak resulting from the collision which damaged the plates, or may have accumulated in the bilge and escaped into the peak even though all the cargo tanks were gas free. (H-38293.)

# Fires in Which There Was Loss of Life.

## First Quarter, 1935.

Since the publication of the January QUARTERLY, the N.F.P.A. Department of Fire Record has received from various sources 229 reports of fires in which there has been loss of life. A total of 366 lives were lost in these fires. Two single disasters involving a loss of ten or more lives have occurred during this period as follows:

JANUARY 21, 1935, GILBERTON, PA. Thirteen miners were reported to have been killed and sixteen were injured as the result of an explosion and fire which trapped them a thousand feet below the surface. Poisonous fumes followed the blast and quickly spread through the mine.

MARCH 7, 1935, ST. GEORGE, UTAH. A premature explosion of nitroglycerin at an oil well was followed by a blast of flame which cost the lives of ten persons, three of them women, and injuries to numerous others. The victims were part of a crowd which had gathered to witness the "blow-in" of the oil well.

## Loss of Life Fires, January-March, 1935.*

*This is a typical rather than a complete record, presented to show the conditions under which loss of life occurs, that they may be known and guarded against. The total loss of life by fire in the United States is estimated at 10,000 annually.*

| Class of Fire | No. Fires | Men | Women | Children | No Data | Total |
|---|---|---|---|---|---|---|
| Airplane fires | 4 | 6 | 0 | 0 | 0 | 6 |
| Apartments, hotels, lodgings, tenements, etc. | 30 | 16 | 16 | 9 | 0 | 41 |
| Automobile fires | 8 | 7 | 2 | 1 | 0 | 10 |
| Dwellings—Rural | 68 | 35 | 26 | 42 | 0 | 103 |
| Dwellings—Urban | 69 | 20 | 38 | 47 | 5 | 110 |
| Garages and filling stations | 4 | 5 | 0 | 0 | 0 | 5 |
| Industrial occupancies | 7 | 9 | 0 | 0 | 0 | 9 |
| Institutions and schools | 2 | 5 | 0 | 1 | 0 | 6 |
| Mercantiles | 7 | 9 | 0 | 0 | 0 | 9 |
| Mining property | 2 | 16 | 0 | 0 | 0 | 16 |
| Oil well | 1 | 7 | 3 | 0 | 0 | 10 |
| Other buildings | 10 | 13 | 2 | 1 | 0 | 16 |
| Outside of buildings | 8 | 4 | 0 | 4 | 0 | 8 |
| Ships and boats | 4 | 10 | 0 | 0 | 0 | 10 |
| Response to alarms | 2 | 1 | 2 | 0 | 0 | 3 |
| Tank trucks | 2 | 3 | 0 | 0 | 0 | 3 |
| No data | 1 | 1 | 0 | 0 | 0 | 1 |
| Total | 229 | 167 | 89 | 105 | 5 | 366 |

*This table is made up from those reports received by the Department of Fire Record between December 20, 1934, and March 20, 1935. A few of the fires included herein occurred prior to December 20, but were not reported until subsequent to that date.

# Causes of Loss of Life, January-March, 1935.

*Fatalities classified according to the immediate cause of the loss of life rather than according to the cause of the fire.*

| Cause | Men | Women | Children | No Data | Total |
|---|---|---|---|---|---|
| Airplane fires | 6 | 0 | 0 | 0 | 6 |
| Automobile fires | 7 | 2 | 1 | 0 | 10 |
| Chemicals and explosives: | | | | | |
| Chemical plant explosion | 1 | 0 | 0 | 0 | 1 |
| Nitroglycerin at oil well | 7 | 3 | 0 | 0 | 10 |
| Children alone in house | 0 | 0 | 24 | 0 | 24 |
| Children and matches | 0 | 0 | 3 | 0 | 3 |
| Clothing ignited: | | | | | |
| Bonfire or rubbish fire | 0 | 1 | 2 | 0 | 3 |
| Bucket of hot tar | 1 | 0 | 0 | 0 | 1 |
| Burning grease | 0 | 1 | 0 | 0 | 1 |
| Fireplace | 0 | 3 | 1 | 0 | 4 |
| Matches ignited while lighting pipe | 1 | 0 | 0 | 0 | 1 |
| Oil lamp | 0 | 2 | 0 | 0 | 2 |
| Oil soaked clothing ignited at furnace | 1 | 0 | 0 | 0 | 1 |
| Stove or heater | 3 | 13 | 2 | 0 | 18 |
| No data | 1 | 4 | 4 | 0 | 9 |
| Electric heater ignited bed | 1 | 1 | 0 | 0 | 2 |
| Entering or re-entering burning buildings | 5 | 1 | 0 | 0 | 6 |
| Escaping from fire: | | | | | |
| Drowned | 6 | 0 | 0 | 0 | 6 |
| Jumped or fell | 1 | 2 | 0 | 0 | 3 |
| Explosions (miscellaneous): | | | | | |
| Air compressor tank | 1 | 0 | 0 | 0 | 1 |
| City gas | 9 | 2 | 2 | 0 | 13 |
| Dynamite in hardware store | 3 | 0 | 0 | 0 | 3 |
| Furnace | 1 | 0 | 1 | 0 | 2 |
| Gasoline blow torch | 0 | 0 | 1 | 0 | 1 |
| Unknown in dwelling | 0 | 1 | 0 | 0 | 1 |
| Unknown in industrial plant | 3 | 0 | 0 | 0 | 3 |
| Whiskey stills (illicit) | 2 | 0 | 0 | 0 | 2 |
| Fire fighting—civilians | 2 | 2 | 0 | 0 | 4 |
| Fire fighting—firemen | 9 | 0 | 0 | 0 | 9 |
| Flammable liquids or vapor: | | | | | |
| Abandoned gasoline tank ignited by boys | 0 | 0 | 1 | 0 | 1 |
| Alcohol explosions | 3 | 0 | 0 | 0 | 3 |
| Alcohol lamp explosion | 0 | 0 | 1 | 0 | 1 |
| "Bootleg" gasoline plant explosion | 1 | 0 | 0 | 0 | 1 |
| Cleaning clothing with flammable liquids | 0 | 3 | 1 | 0 | 4 |
| Gasoline ignited by blow torch | 1 | 0 | 0 | 0 | 1 |
| Gasoline ignited in kitchen—no data | 0 | 1 | 0 | 0 | 1 |
| Gasoline stove exploded | 2 | 1 | 3 | 0 | 6 |
| Gasoline used to start fire | 1 | 0 | 0 | 0 | 1 |
| Heating gasoline and paraffine mixture | 0 | 1 | 0 | 0 | 1 |
| Kerosene on stove exploded | 0 | 2 | 0 | 0 | 2 |
| Kerosene used to start fire | 7 | 6 | 8 | 0 | 21 |
| Ignition of vapor in fuel oil tank | 3 | 0 | 0 | 0 | 3 |
| Oil on stove exploded | 0 | 0 | 3 | 0 | 3 |
| Oil lamp, stove, lantern explosion | 2 | 2 | 0 | 0 | 4 |
| Paint and gasoline mixture exploded | 0 | 0 | 1 | 0 | 1 |
| Tank truck exploded during washing | 1 | 0 | 0 | 0 | 1 |
| Mine fires and explosions | 16 | 0 | 0 | 0 | 16 |
| Motion picture film fire in dwelling | 0 | 2 | 4 | 0 | 6 |
| Overcome by smoke—suffocation | 4 | 10 | 2 | 5 | 21 |
| Overexertion or excitement | 1 | 0 | 0 | 0 | 1 |
| Response to alarms | 1 | 2 | 0 | 0 | 3 |

| Cause | Men | Women | Children | No Data | Total |
|---|---|---|---|---|---|
| Ship fires (exclusive of drowning) | 4 | 0 | 0 | 0 | 4 |
| Smoking in bed | 5 | 2 | 0 | 0 | 7 |
| Tank truck struck by train | 2 | 0 | 0 | 0 | 2 |
| Trapped in burning building | 41 | 18 | 42 | 0 | 99 |
| No data | 1 | 1 | 0 | 0 | 2 |
| Total | 167 | 89 | 107 | 5 | 366 |

## Typical Loss of Life Fires.

### Alcohol Lamp Explosion.

H-38940. WINTERBOURNE, ONT., FEBRUARY 1, 1935. A ten-year-old girl was burned to death when her clothing ignited as she attempted to beat out a fire on her teacher's desk caused by the explosion of an alcohol lamp. The lamp was being used by boys in the agricultural class for milk testing experiments. The teacher was not in the room when the accident occurred.

### Children Alone in House.

L-2860. COPPER CLIFF, ONT., JANUARY 29, 1935. Three children were burned to death in a fire which occurred when they were left alone in their home for ten minutes. Their mother was at the home of a neighbor, and when she returned the house was so completely enveloped in smoke that it was impossible to enter.

L-2861. WASHINGTON, D. C., FEBRUARY 20, 1935. An eight-year-old girl was burned to death while locked in an apartment with her seven-months-old sister. Hearing screams, a policeman broke the door and found the girl on the floor with her clothing ablaze. It is believed that the child was playing with matches.

### Children Playing with Chemicals.

L-2862. WASHINGTON, D. C., FEBRUARY 10, 1935. A ten-year-old girl was burned to death when her clothing ignited as she watched her brother making a "green flame" with a chemical set which he had received as a Christmas gift. The fatality occurred when the boy tossed a lighted match into a pan filled with alcohol. Flames shot up nearly to the ceiling, igniting the victim's dress, which was burned off before the fire was extinguished by putting her in the bath tub. The children were alone at the time.

### Warming Motor Oil on Stove.

L-2874. MISHAWAKA, IND., DECEMBER 27, 1934. Three small children were burned to death and their father was seriously burned as a result of a fire which destroyed their three-room home. The father had placed a kettle of motor oil on the stove to warm it in order to start his car more easily. He left the house for a few minutes and during his absence the oil ignited. The father was overcome when he ran inside in an attempt to save the children. He was revived, but the children were suffocated before they could be carried out.

### Gasoline Blow Torch.

L-2863. SAVANNAH BEACH, GA., FEBRUARY 18, 1935. A fourteen-year-old boy attempted to operate a gasoline blow torch which he intended to use for melting lead in connection with making artificial minnows from clothespins. Being unfamiliar with its operation, he encountered some trouble, and surplus gasoline on the lip of the torch ignited. The boy's uncle, seeing the torch blazing, rushed into the garage where the boy was working, and threw the blazing torch outside, where it exploded in the midst of three little girls who had just approached on roller skates. The man extinguished their burning clothing, but one of them was so severely burned that she died later in a hospital.

### Cleaning with Flammable Liquids.

L-2864. ST. HYACINTHE, P. Q., JANUARY 3, 1935. A woman was burned to death when her clothing caught fire while she was washing clothes in gasoline. The victim was working in the kitchen and spilled gasoline on the lighted stove. She rushed from the house, where her flaming clothing was extinguished by a policeman. She died later in a hospital.

L-2865. PROVIDENCE, R. I., JANUARY 28, 1935. A woman was fatally burned and died in a hospital a week later as a result of using flammable cleaning fluid to clean a dress. Fumes from the liquid ignited from the pilot light on the kitchen stove.

### Electric Heater Ignited Bed.

L-2866. NEW YORK, N. Y., DECEMBER 31, 1934. A seventy-year-old crippled woman was burned to death when an electric heating pad ignited her bedding. The fire started at 4:30 A.M. and spread rapidly through the tenement house, making it impossible for firemen to reach the victim.

L-2867. BALTIMORE, MD., JANUARY 22, 1935. An invalid man was fatally burned when an electric heater set fire to his bed. His wife was burned while attempting to extinguish the fire.

### Explosion of Abandoned Gasoline Tank.

L-2868. BOSTON, MASS., DECEMBER 28, 1934. The explosion of the gasoline tank of an abandoned automobile on a vacant lot cost the life of a three-year-old girl. Her six-year-old brother was badly burned when he attempted to beat out the fire in her clothing. The explosion occurred when one of a group of children kicked embers from a rubbish fire under the old machine.

### Motion Picture Film Ignited in Dwelling.

L-2869. MONTREAL, P. Q., JANUARY 16, 1935. Two women and four children lost their lives and twelve other persons were injured when trapped in a play room by burning nitrocellulose motion picture film. The operator had placed his machine in the doorway leading to the hall which formed the only exit from the room. When the fire started in the film the operator ran

out. The fire involved a Christmas tree, which, with five rolls of burning film, caused an intense and asphyxiating fire.

**Re-entering Burning Building.**

L-2870. ROCKY FORD, GA., JANUARY 24, 1935. An elderly farmer lost his life as a result of his efforts to save furniture from his burning home. He was overcome by smoke and died a week later.

L-2871. FRANKLIN, VT., FEBRUARY 25, 1935. A farmer was burned to death when he went back into his burning home in an effort to save a trunk containing his life's savings, estimated to amount to $2000.

L-2872. RUTLAND, VT., MARCH 4, 1935. A man was burned to death while trying to remove furniture from his burning home. His charred body was found in the ruins.

L-2873. ILCHESTER, MD., MARCH 12, 1935. A retired school teacher was burned to death when she returned to her burning home in an effort to save one hundred dollars in a pocket book. She had been to her room and secured the pocket book and was in the front doorway when she collapsed and was burned to death.

*"Be It Ever So Humble."*

ONE GALLON OF GASOLINE CAN DO WONDERS WHEN USED PROPERLY —
BUT THE CARELESS USE OF GASOLINE FOR CLEANING PURPOSES IN THE HOME CAN AND DOES CAUSE 11¼ MILLION DOLLARS WORTH OF FIRE LOSS IN THE U.S. EVERY YEAR.
HOME SWEET HOME
FRED O SEIBEL

*Richmond, Va., Times-Dispatch.*

# Annual Sprinkler Tables.

## Statistics of Fires in Properties Having Automatic Sprinkler Protection.

**NOTE.—These tabulations are made at the close of each year with the object of furnishing a basis upon which the efficiency of the automatic sprinkler as an extinguishing agent can be estimated.**

**Section I is devoted to fires in which the behavior of sprinklers was, for the reasons given, unsatisfactory.**

**Section II is a statistical record of all reports of sprinkler fires in the files of the Association upon which the information obtained is sufficiently complete for statistical purposes.**

**In these tables the results of the current year ending February 1, 1935, are given and these are compared with the results of the total thirty-seven year record ending at that time.**

The annual sprinkler tabulation is published this year for the thirty-ninth consecutive year. The tables which follow show the actual fire experience with automatic sprinkler equipments in sixty-eight thousand six hundred fires. This is not intended as a complete statistical report of fires in sprinklered properties; it includes only those fires reported to the N.F.P.A. Department of Fire Record in sufficient detail to give the data necessary for the tables. While the fires included in this tabulation are probably only a fraction of the total number of fires occurring in buildings under sprinkler protection, with a total of 68,600 fires in the record and current reports being received at an average rate of approximately three thousand annually, there can be no doubt that this summary as a whole is completely representative.

An exception to this statement may be made in the case of the detailed records of experience in some occupancies where only a comparatively small number of fires are reported. In order to maintain the continuity of the tables from year to year it is necessary to have every occupancy classification appear, even though there be but one sprinklered fire reported. It is obvious, however, that conclusions should not be drawn as to the effectiveness of sprinklers in an occupancy where the number of fires reported is so small that the figures may be distorted by some one unusual fire.

The total number of sprinklered fire reports received during the past year was 2700. This total includes 451 fires in which the sprinklers were not a factor. This latter classification includes fires occurring in unsprinklered portions of buildings which did not extend to the sprinklered portions, or fires occurring in sprinklered portions which were discovered and extinguished by other means before there was sufficient heat to open sprinklers. The total number of fires since 1897 in sprinklered properties where sprinklers were not a factor is 12,928.

The classifications "extinguished fire" and "held fire in check" appearing in the several tables may both be considered as satisfactory performance. The distinction between these two classifications is necessarily more or less arbitrary, depending upon the judgment of the original inspector. The great majority of the fires in the "held in check" columns are instances where hose streams or other equipment were used to extinguish fire in spaces which water from the sprinklers did not reach because of minor obstructions to distribution or unsprinklered portions, but where sprinklers functioned satisfactorily in preventing the spread of fire.

When reviewing the detailed tabulation of unsatisfactory sprinkler performance it should be noted that these fires represent a small percentage of the total number included in the record and that they are compiled not with the thought of emphasizing the relatively few cases where sprinkler operation is unsatisfactory, but pointing the way toward better performance by indicating those factors which should receive attention.

As a result of inquiries by N.F.P.A. members as to what constitutes "Unsatisfactory" sprinkler control, explanation is given in greater detail this year. The annual sprinkler tables are designed to show to what degree fires have been automatically controlled in buildings equipped with automatic sprinklers. The term "Unsatisfactory" does not necessarily imply mechanical failure of the sprinkler equipment. Neither does it indicate that there was a large loss in a sprinklered building. "Unsatisfactory" sprinkler control means that for various reasons the sprinkler equipment did not automatically extinguish the fire or hold it in check. Reasons for "Unsatisfactory" sprinkler control are shown in Section I, and in Table No. 5 of Section II, of the following tables. In many of the fires where automatic sprinkler control was "Unsatisfactory" the loss was small, due to prompt extinguishment by other fire fighting equipment.

The record of sprinkler efficiency for 1934-1935 is 96.4 per cent, which is slightly above the average for the entire period of the sprinkler tables which were first published in 1897. The tables give a conservative picture of the efficiency of sprinklers. It should be noted that there are a large number of fires annually which are extinguished by sprinklers where no claim for loss is made and where no report reaches the Department of Fire Record. If it were possible to include all such fires in the tables the sprinkler efficiency would approach much nearer to one hundred per cent.

The tables follow the same general plan and arrangement as in previous years. There has been one new occupancy classification added during the year, namely, Telephone Exchanges, which were formerly included in "Miscellaneous." The tables include twenty-six fires in properties protected by thermostatically operated open head systems. These are separately listed in Section II, Tables 2 and 3.

## SECTION I.

### Summary of Unsatisfactory Sprinkler Fires.

| | 1934-1935 No. of Fires | 1934-1935 Per Cent | 1897-1935 No. of Fires | 1897-1935 Per Cent |
|---|---|---|---|---|
| Water shut off | 35 | 43.2 | 724 | 32.4 |
| Generally defective equipment | 7 | 8.6 | 395 | 17.7 |
| Unsprinklered portions | 2 | 2.5 | | |
| Defective water supply or supplies | 5 | 6.2 | 197 | 8.8 |
| Sprinkler system crippled due to freezing | 7 | 8.6 | 68 | 3.0 |
| Slow operation of dry system or defective valve | 4 | 4.9 | 71 | 3.2 |
| Slow or defective operation of high test heads | .. | .. | 27 | 1.2 |
| Faulty building construction, concealed spaces, vertical openings, etc. | 2 | 2.5 | 111 | 4.9 |
| Obstruction to distribution | 1 | 1.2 | 133 | 5.9 |
| Hazard of occupancy too severe for average sprinkler equipment | 5 | 6.2 | 127 | 5.7 |
| Explosion crippled sprinkler system | 5 | 6.2 | 109 | 4.9 |
| Exposure or conflagration | 2 | 2.5 | 89 | 4.0 |
| Plugged heads and piping (included with Miscellaneous Prior to 1921) | 3 | 3.7 | 47 | 2.1 |
| Miscellaneous | 3 | 3.7 | 138 | 6.2 |
| Total | 81 | 100.0 | 2236 | 100.0 |

### Fires in Which Failure Was Due to Water Shut Off Sprinklers.

| | 1934-1935 No. of Fires | 1897-1935 No. of Fires |
|---|---|---|
| Water shut off for unknown reason, neglect or carelessness | 4 | 214 |
| Water shut off before fire was out, or fire rekindled | 11 | 132 |
| Water shut off due to accidents or repairs | 1 | 107 |
| Water shut off to prevent freezing | 12 | 168 |
| Water shut off, probably incendiary | 3 | 33 |
| Water shut off, leaky dry system | 1 | 18 |
| Water shut off, defective gate valve | — | 9 |
| Water shut off, miscellaneous | 3 | 45 |
| Total | 35 | 726 |

## SECTION II.

### Annual Revision of Sprinkler Fire Tables.

The following tables are a summary of fires occurring in properties equipped with automatic sprinklers. The total number of such fires reported during the past year was 2700, which includes 451 fires where no sprinklers were opened. A number of reports were received in which the data were incomplete and these are not included in this tabulation.

## Table No. 1—Effect of Sprinklers.

| | 1934-1935 No. of Fires | % | 1897-1935 No. of Fires | % |
|---|---|---|---|---|
| Practically or entirely extinguished... | 1753 | 77.9 | 38892 | 69.9 |
| Held fire in check..... | 415 | 18.5 | 14539 | 26.1 |
| Total Satisfactory..... | 2168 | 96.4 | 53431 | 96.0 |
| Unsatisfactory ..... | 81 | 3.6 | 2236 | 4.0 |
| Total..... | 2249 | | 55667 | |

## Table No. 2—Number of Sprinklers Operating.

No. of Fires, 1897-1935.

| No. of Sprinklers Operating | Wet | % | Dry | % | No Data | Total | % |
|---|---|---|---|---|---|---|---|
| 1 ..... | 16665 | 38.5 | 1887 | 20.3 | 701 | 19253 | 34.8 |
| 2 or less..... | 24694 | 57.0 | 3203 | 34.4 | 1020 | 28917 | 52.2 |
| 3 or less..... | 28973 | 66.9 | 4017 | 43.2 | 1205 | 34195 | 61.7 |
| 4 or less..... | 31914 | 73.7 | 4694 | 50.5 | 1354 | 37962 | 68.5 |
| 5 or less..... | 33679 | 77.8 | 5126 | 55.1 | 1450 | 40255 | 72.6 |
| 6 or less..... | 35095 | 81.1 | 5527 | 59.4 | 1529 | 42151 | 76.0 |
| 7 or less..... | 36091 | 83.3 | 5840 | 62.8 | 1575 | 43506 | 78.5 |
| 8 or less..... | 37014 | 85.4 | 6101 | 65.4 | 1628 | 44743 | 80.7 |
| 9 or less..... | 37628 | 86.8 | 6312 | 67.9 | 1663 | 45603 | 82.3 |
| 10 or less..... | 38184 | 88.1 | 6491 | 69.8 | 1708 | 46383 | 83.7 |
| 11 or less..... | 38596 | 89.1 | 6643 | 71.4 | 1728 | 46967 | 84.8 |
| 12 or less..... | 39051 | 90.2 | 6837 | 73.5 | 1772 | 47660 | 86.1 |
| 13 or less..... | 39317 | 90.8 | 6979 | 75.0 | 1790 | 48086 | 86.9 |
| 14 or less..... | 39625 | 91.5 | 7112 | 76.4 | 1814 | 48551 | 87.7 |
| 15 or less..... | 39871 | 92.1 | 7231 | 77.7 | 1832 | 48934 | 88.4 |
| 20 or less..... | 40739 | 94.1 | 7616 | 81.8 | 1906 | 50261 | 90.8 |
| 25 or less..... | 41248 | 95.3 | 7903 | 84.9 | 1939 | 51090 | 92.3 |
| 30 or less..... | 41594 | 96.1 | 8096 | 87.0 | 1963 | 51653 | 93.3 |
| 35 or less..... | 41809 | 96.6 | 8229 | 88.4 | 1981 | 52019 | 93.9 |
| 40 or less..... | 41998 | 97.1 | 8340 | 89.6 | 2001 | 52339 | 94.5 |
| 50 or less..... | 42230 | 97.6 | 8496 | 91.3 | 2028 | 52754 | 95.3 |
| 75 or less..... | 42556 | 98.4 | 8703 | 93.5 | 2058 | 53317 | 96.3 |
| 100 or less..... | 42702 | 98.7 | 8810 | 94.6 | 2069 | 53581 | 96.8 |
| Over 100..... | 445 | | 373 | | 45 | 863 | |
| No data..... | 112 | | 101 | | 650 | 863 | |
| Open head systems | 0 | | 26 | | 0 | 26 | |
| Total..... | 43259 | | 9310 | | 2764 | 55333 | |
| Water shut off sprinklers..... | | | | | | 334 | |
| Total..... | | | | | | 55667 | |

## Table No. 3—Numbers of Sprinklers Operating.

| No. of Sprinklers Operating | No. of Fires, 1934-1935. Wet | % | Dry | % | No Data | Total | % |
|---|---|---|---|---|---|---|---|
| 1 | 770 | 43.9 | 84 | 20.7 | 31 | 885 | 39.3 |
| 2 | 332 | 18.9 | 70 | 17.3 | 11 | 413 | 18.3 |
| 3 | 147 | 8.4 | 38 | 9.4 | 5 | 190 | 8.5 |
| 4 | 108 | 6.1 | 36 | 8.9 | 1 | 145 | 6.5 |
| 5 | 57 | 3.3 | 27 | 6.7 | 3 | 87 | 3.9 |
| 6 | 55 | 3.1 | 13 | 3.2 | 3 | 71 | 3.2 |
| 7 | 39 | 2.2 | 12 | 3.0 | 0 | 51 | 2.3 |
| 8 | 34 | 1.9 | 12 | 3.0 | 0 | 46 | 2.0 |
| 9 | 18 | 1.0 | 8 | 2.0 | 0 | 26 | 1.2 |
| 10 | 20 | 1.1 | 7 | 1.7 | 1 | 28 | 1.3 |
| 11 | 17 | 1.0 | 7 | 1.7 | 0 | 24 | 1.1 |
| 12 | 19 | 1.1 | 5 | 1.2 | 3 | 27 | 1.2 |
| 13 | 9 | .5 | 4 | 1.0 | 1 | 14 | .6 |
| 14 | 11 | .6 | 7 | 1.7 | 2 | 20 | .9 |
| 15 | 6 | .3 | 3 | .7 | 2 | 11 | .5 |
| 16-20 | 33 | 1.9 | 16 | 3.9 | 1 | 50 | 2.2 |
| 21-25 | 17 | 1.0 | 9 | 2.2 | 2 | 28 | 1.2 |
| 26-30 | 8 | .4 | 4 | 1.0 | 0 | 12 | .5 |
| 31-35 | 5 | .3 | 8 | 2.0 | 1 | 14 | .6 |
| 36-40 | 5 | .3 | 1 | .3 | 1 | 7 | .3 |
| 41-50 | 4 | .2 | 4 | 1.0 | 2 | 10 | .4 |
| 51-75 | 8 | .8 | 5 | 1.2 | 8 | 21 | .9 |
| 76-100 | 5 | .3 | 2 | .5 | 1 | 8 | .4 |
| Over 100 | 14 | .8 | 12 | 3.0 | 5 | 31 | 1.4 |
| No data | 11 | .6 | 4 | 1.0 | 8 | 23 | 1.0 |
| Open head systems | 0 | .. | 7 | 1.7 | 0 | 7 | .3 |
| Total | 1752 | 100.0 | 405 | 100.0 | 92 | 2249 | 100.0 |

| No. of Sprinklers Operating | No. of Fires, 1897-1935. Wet | % | Dry | % | No Data | Total | % |
|---|---|---|---|---|---|---|---|
| 1 | 16665 | 38.5 | 1887 | 20.3 | 701 | 19253 | 34.8 |
| 2 | 8029 | 18.5 | 1316 | 14.1 | 319 | 9664 | 17.4 |
| 3 | 4279 | 9.9 | 814 | 8.8 | 185 | 5278 | 9.5 |
| 4 | 2941 | 6.8 | 677 | 7.3 | 149 | 3767 | 6.8 |
| 5 | 1765 | 4.1 | 432 | 4.6 | 96 | 2293 | 4.1 |
| 6 | 1416 | 3.3 | 401 | 4.3 | 79 | 1896 | 3.4 |
| 7 | 996 | 2.2 | 313 | 3.4 | 46 | 1355 | 2.5 |
| 8 | 923 | 2.1 | 261 | 2.8 | 53 | 1237 | 2.2 |
| 9 | 614 | 1.4 | 211 | 2.3 | 35 | 860 | 1.6 |
| 10 | 556 | 1.3 | 179 | 1.9 | 45 | 780 | 1.4 |
| 11 | 412 | 1.0 | 152 | 1.6 | 20 | 584 | 1.1 |
| 12 | 455 | 1.1 | 194 | 2.1 | 44 | 693 | 1.3 |
| 13 | 266 | .6 | 142 | 1.5 | 18 | 426 | .8 |
| 14 | 308 | .7 | 133 | 1.4 | 24 | 465 | .8 |
| 15 | 246 | .6 | 119 | 1.3 | 18 | 383 | .7 |
| 16-20 | 868 | 2.0 | 385 | 4.1 | 74 | 1327 | 2.4 |
| 21-25 | 509 | 1.2 | 287 | 3.1 | 33 | 829 | 1.5 |
| 26-30 | 346 | .8 | 193 | 2.1 | 24 | 563 | 1.0 |
| 31-35 | 215 | .5 | 133 | 1.4 | 18 | 366 | .6 |
| 36-40 | 189 | .5 | 111 | 1.2 | 20 | 320 | .6 |
| 41-50 | 232 | .5 | 156 | 1.7 | 27 | 415 | .8 |
| 51-75 | 326 | .8 | 207 | 2.2 | 30 | 563 | 1.0 |
| 76-100 | 146 | .3 | 107 | 1.1 | 11 | 264 | .5 |
| Over 100 | 445 | 1.0 | 373 | 4.0 | 45 | 863 | 1.6 |
| No data | 112 | .3 | 101 | 1.1 | 650 | 863 | 1.6 |
| Open head systems | 0 | .. | 26 | .3 | 0 | 26 | .. |
| Total | 43259 | 100.0 | 9310 | 100.0 | 2764 | 55333 | 100.0 |
| Water shut off sprinklers | | | | | | 334 | |
| Total | | | | | | 55667 | |

## Table No. 4—Effect of Sprinklers by Class of Occupancy.

| | Extinguished Fire | | Held Fire in Check | | Total Satisfactory | | Unsatisfactory | | Total No. of Fires |
|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | |
| Abrasive Works | 29 | 74.4 | 8 | 20.5 | 37 | 94.9 | 2 | 5.1 | 39 |
| Agricultural Implements | 84 | 61.3 | 48 | 35.0 | 132 | 96.3 | 5 | 3.7 | 137 |
| Airplane Factories | 8 | 53.3 | 7 | 46.7 | 15 | 100.0 | 0 | .. | 15 |
| Airports and Hangars | 3 | 42.9 | 4 | 57.1 | 7 | 100.0 | 0 | .. | 7 |
| Alcohol Distilleries | 1 | 25.0 | 2 | 50.0 | 3 | 75.0 | 1 | 25.4 | 4 |
| Aluminum Works | 6 | 50.0 | 4 | 33.3 | 10 | 83.3 | 2 | 16.7 | 12 |
| Amusement Places | 33 | 82.5 | 3 | 7.5 | 36 | 90.0 | 4 | 10.0 | 40 |
| Apartment Houses | 163 | 86.3 | 26 | 13.7 | 189 | 100.0 | 0 | .. | 189 |
| Artificial Leather Mfg. | 35 | 53.9 | 27 | 41.5 | 62 | 95.4 | 3 | 4.6 | 65 |
| Asbestos Works | 25 | 55.6 | 17 | 37.8 | 42 | 93.4 | 3 | 6.6 | 45 |
| Automobile Mfg. | 357 | 66.8 | 157 | 29.4 | 514 | 96.2 | 21 | 3.8 | 535 |
| Automobile Body Mfg. | 163 | 59.8 | 85 | 31.1 | 248 | 90.9 | 25 | 9.1 | 273 |
| Automobile Paint Shops | 11 | 68.8 | 5 | 31.2 | 16 | 100.0 | 0 | .. | 16 |
| Auto Sales and Service | 42 | 68.9 | 13 | 21.3 | 55 | 90.2 | 6 | 9.8 | 61 |
| Bag Factories | 52 | 62.7 | 27 | 32.5 | 79 | 95.2 | 4 | 4.8 | 83 |
| Bakeries | 213 | 77.5 | 54 | 19.6 | 267 | 97.1 | 8 | 2.9 | 275 |
| Basket Factories | 15 | 83.4 | 2 | 11.1 | 17 | 94.5 | 1 | 5.5 | 18 |
| Battery Mfg. | 43 | 67.2 | 18 | 28.2 | 61 | 95.4 | 3 | 4.6 | 64 |
| Bolt, Nut and Screw Works | 27 | 60.0 | 15 | 33.3 | 42 | 93.3 | 3 | 6.7 | 45 |
| Bottle Caps and Seals Mfg. | 48 | 55.6 | 40 | 44.4 | 88 | 100.0 | 0 | .. | 88 |
| Bottling Works | 10 | 77.0 | 2 | 15.4 | 12 | 92.4 | 1 | 7.6 | 13 |
| Braid Mills | 69 | 77.5 | 18 | 20.2 | 87 | 97.7 | 2 | 2.3 | 89 |
| Brass and Copper Works | 88 | 73.9 | 28 | 23.5 | 116 | 97.4 | 3 | 2.6 | 119 |
| Breweries | 5 | 62.5 | 3 | 37.5 | 8 | 100.0 | 0 | .. | 8 |
| Brick and Tile Works | 1 | 100.0 | 0 | .. | 1 | 100.0 | 0 | .. | 1 |
| Broom Factories | 23 | 67.7 | 8 | 23.5 | 31 | 91.2 | 3 | 8.8 | 34 |
| Brush Factories | 35 | 71.4 | 13 | 26.6 | 48 | 98.0 | 1 | 2.0 | 49 |
| Buildings Under Construction | 5 | 62.5 | 3 | 37.5 | 8 | 100.0 | 0 | .. | 8 |
| Button Factories | 79 | 83.3 | 14 | 14.6 | 93 | 97.9 | 2 | 2.1 | 95 |
| Candle Factories | 9 | 56.2 | 7 | 43.8 | 16 | 100.0 | 0 | .. | 16 |
| Candy Factories | 258 | 72.5 | 87 | 24.4 | 345 | 96.9 | 11 | 3.1 | 356 |
| Canneries | 21 | 65.7 | 8 | 25.0 | 29 | 90.7 | 3 | 9.3 | 32 |
| Canvas and Cotton Belting | 8 | 66.7 | 4 | 33.3 | 12 | 100.0 | 0 | .. | 12 |
| Carbon Works | 12 | 85.8 | 2 | 14.2 | 14 | 100.0 | 0 | .. | 14 |
| Car Houses | 47 | 46.0 | 46 | 45.1 | 93 | 91.1 | 9 | 8.9 | 102 |
| Car Works | 83 | 61.0 | 48 | 35.4 | 131 | 96.4 | 5 | 3.6 | 136 |
| Carpet and Rug Mills | 222 | 65.4 | 107 | 31.5 | 329 | 96.9 | 11 | 3.1 | 340 |
| Casket Mfg. | 83 | 75.5 | 22 | 20.0 | 105 | 95.5 | 5 | 4.5 | 110 |
| Cement and Plaster Mills | 14 | 70.0 | 3 | 15.0 | 17 | 85.0 | 3 | 15.0 | 20 |
| Cereal Mills | 44 | 63.8 | 17 | 24.6 | 61 | 78.4 | 8 | 21.6 | 69 |
| Chemical and White Lead Works | 228 | 62.4 | 113 | 30.8 | 341 | 93.2 | 25 | 6.8 | 366 |
| Churches | 1 | 100.0 | 0 | .. | 1 | 100.0 | 0 | .. | 1 |
| Clock and Watch Mfg. | 19 | 79.2 | 5 | 20.8 | 24 | 100.0 | 0 | .. | 24 |
| Clothing Mfg. | 2396 | 86.0 | 366 | 13.1 | 2762 | 99.1 | 22 | .9 | 2784 |
| Clubs—City | 30 | 81.2 | 6 | 16.7 | 36 | 97.9 | 1 | 2.1 | 37 |
| Clubs—Country | 13 | 65.0 | 7 | 35.0 | 20 | 100.0 | 0 | .. | 20 |
| Coal and Wood Yards | 3 | 27.2 | 7 | 63.6 | 10 | 91.8 | 1 | 8.2 | 11 |
| Cocoanut Mills | 6 | 75.0 | 2 | 25.0 | 8 | 100.0 | 0 | .. | 8 |
| Coffee and Spice Mills | 102 | 70.9 | 38 | 26.4 | 140 | 97.3 | 4 | 2.7 | 144 |
| Cold Storage Plants | 17 | 68.0 | 8 | 32.0 | 25 | 100.0 | 0 | .. | 25 |
| Cooperage Plants | 67 | 60.9 | 31 | 27.2 | 98 | 88.1 | 12 | 11.9 | 110 |
| Cordage Works | 266 | 65.2 | 126 | 30.9 | 392 | 96.1 | 16 | 3.9 | 408 |
| Cork Factories | 32 | 53.4 | 23 | 38.3 | 55 | 91.7 | 5 | 8.3 | 60 |
| Cotton Gins | 12 | 63.2 | 5 | 26.3 | 17 | 89.5 | 2 | 10.5 | 19 |
| Cotton Mills | 6509 | 66.1 | 3224 | 32.7 | 9733 | 98.8 | 117 | 1.2 | 9850 |
| Cotton Seed Oil Mills | 47 | 48.0 | 31 | 31.6 | 78 | 79.6 | 20 | 20.4 | 98 |
| Cotton Warehouses | 267 | 50.8 | 213 | 40.5 | 480 | 91.3 | 46 | 8.7 | 526 |
| Cutlery Mfg. | 30 | 60.0 | 17 | 34.0 | 47 | 94.0 | 3 | 6.0 | 50 |
| Dairies and Creameries | 10 | 77.0 | 3 | 23.0 | 13 | 100.0 | 0 | .. | 13 |

| | Extinguished Fire | | Held Fire in Check | | Total Satisfactory | | Unsatisfactory | | Total No. of Fires |
|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | |
| Department Stores | 803 | 79.8 | 180 | 17.9 | 983 | 97.7 | 23 | 2.3 | 1006 |
| Distilleries | 12 | 60.0 | 5 | 25.0 | 17 | 85.0 | 3 | 15.0 | 20 |
| Doll Factories | 92 | 67.6 | 44 | 32.4 | 136 | 100.0 | 0 | .. | 136 |
| Drug Mfg. and Warehouses | 277 | 80.5 | 60 | 17.5 | 337 | 98.0 | 7 | 2.0 | 344 |
| Dry Cleaning Establishments | 21 | 65.7 | 11 | 34.3 | 32 | 100.0 | 0 | .. | 32 |
| Dry Goods Stores | 405 | 86.3 | 59 | 12.5 | 464 | 98.8 | 6 | 1.2 | 470 |
| Dwellings | 1 | 50.0 | 0 | .. | 1 | 50.0 | 1 | 50.0 | 2 |
| Dyeing, Bleaching, Finishing | 331 | 60.4 | 198 | 36.2 | 529 | 96.6 | 19 | 3.4 | 548 |
| Electrical Appliance Mfg. | 578 | 73.3 | 198 | 25.1 | 776 | 98.4 | 13 | 1.6 | 789 |
| Electric Power and Light | 9 | 45.0 | 8 | 40.0 | 17 | 85.0 | 3 | 15.0 | 20 |
| Excelsior Factories | 36 | 68.0 | 13 | 24.5 | 49 | 92.5 | 4 | 7.5 | 53 |
| Fertilizer Plants | 33 | 66.0 | 13 | 26.0 | 46 | 92.0 | 4 | 8.0 | 50 |
| Fibre Products | 17 | 51.5 | 14 | 42.4 | 31 | 93.9 | 2 | 6.1 | 33 |
| Fireworks Plants | 1 | 20.0 | 3 | 60.0 | 4 | 80.0 | 1 | 20.0 | 5 |
| Flax and Linen Mills | 53 | 58.2 | 37 | 40.7 | 90 | 98.9 | 1 | 1.1 | 91 |
| Flour and Grist Mills | 96 | 53.6 | 52 | 29.1 | 148 | 82.7 | 31 | 17.3 | 179 |
| Forge and Smithy | 31 | 73.8 | 10 | 23.8 | 41 | 97.6 | 1 | 2.4 | 42 |
| Foundries | 264 | 61.8 | 144 | 33.7 | 408 | 95.5 | 19 | 4.5 | 427 |
| Fruit Packing | 10 | 100.0 | 0 | .. | 10 | 100.0 | 0 | .. | 10 |
| Fur Works | 229 | 93.5 | 11 | 4.5 | 240 | 98.1 | 5 | 2.0 | 245 |
| Furniture Factories | 1098 | 68.7 | 389 | 24.3 | 1487 | 93.0 | 113 | 7.0 | 1600 |
| Furniture Stores | 143 | 78.6 | 31 | 17.0 | 174 | 95.6 | 8 | 4.4 | 182 |
| Garages | 639 | 71.6 | 235 | 26.3 | 874 | 97.9 | 19 | 2.1 | 893 |
| Garbage Reduction Plants | 3 | 60.0 | 1 | 20.0 | 4 | 80.0 | 1 | 20.0 | 5 |
| Gas Works | 3 | 42.9 | 3 | 42.9 | 6 | 85.8 | 1 | 14.2 | 7 |
| General Stores | 1 | 50.0 | 1 | 50.0 | 2 | 100.0 | 0 | .. | 2 |
| Glass Factories | 109 | 60.9 | 52 | 29.0 | 161 | 89.9 | 18 | 10.1 | 179 |
| Glove Factories | 21 | 67.8 | 9 | 29.0 | 30 | 96.8 | 1 | 3.2 | 31 |
| Glue Factories | 10 | 45.5 | 9 | 40.9 | 19 | 86.4 | 3 | 13.6 | 22 |
| Grain Elevators | 40 | 40.4 | 32 | 32.3 | 72 | 72.7 | 27 | 27.3 | 99 |
| Groceries | 230 | 79.0 | 50 | 17.2 | 280 | 96.2 | 11 | 3.8 | 291 |
| Gum Mfg. | 9 | 81.8 | 2 | 18.2 | 11 | 100.0 | 0 | .. | 11 |
| Hair Works | 29 | 80.6 | 7 | 19.4 | 36 | 100.0 | 0 | .. | 36 |
| Hardware Stores | 133 | 82.7 | 25 | 15.5 | 158 | 98.2 | 3 | 1.8 | 161 |
| Hat Factories | 472 | 80.5 | 93 | 15.9 | 565 | 96.4 | 21 | 3.6 | 586 |
| Hospitals | 36 | 83.7 | 7 | 16.3 | 43 | 100.0 | 0 | .. | 43 |
| Hotels—Year Round | 120 | 83.8 | 20 | 13.8 | 140 | 97.6 | 5 | 3.4 | 145 |
| Hotels—Seasonal | 18 | 66.7 | 8 | 29.6 | 26 | 96.3 | 1 | 3.7 | 27 |
| Ice Cream Mfg. | 7 | 58.3 | 5 | 41.7 | 12 | 100.0 | 0 | .. | 12 |
| Ice Houses | 0 | .. | 2 | 66.7 | 2 | 66.7 | 1 | 33.3 | 3 |
| Ice Manufacturing | 2 | 66.7 | 1 | 33.3 | 3 | 100.0 | 0 | .. | 3 |
| Idle and Vacant Property | 46 | 53.5 | 16 | 18.6 | 62 | 72.1 | 24 | 27.9 | 86 |
| Incandescent Lamp Works | 27 | 67.5 | 13 | 32.5 | 40 | 100.0 | 0 | .. | 40 |
| Institutions | 17 | 94.5 | 1 | 5.5 | 18 | 100.0 | 0 | .. | 18 |
| Insulated Wire Works | 67 | 67.0 | 31 | 31.0 | 98 | 98.0 | 2 | 2.0 | 100 |
| Jewelry Factories | 214 | 83.9 | 33 | 13.9 | 247 | 97.8 | 8 | 2.2 | 255 |
| Junk Shops | 32 | 64.0 | 13 | 26.0 | 45 | 90.0 | 5 | 10.0 | 50 |
| Knitting Mills—Cop Yarn | 70 | 67.2 | 27 | 26.1 | 97 | 93.3 | 7 | 6.7 | 104 |
| Knitting Mills—Full Process | 688 | 69.0 | 277 | 27.9 | 965 | 96.9 | 31 | 3.1 | 996 |
| Lamp Shade Factories | 53 | 93.0 | 3 | 5.3 | 56 | 98.3 | 1 | 1.7 | 57 |
| Laundries | 189 | 75.6 | 54 | 21.6 | 243 | 97.2 | 7 | 2.8 | 250 |
| Lead Pencil Factories | 20 | 71.5 | 7 | 25.0 | 27 | 96.5 | 1 | 3.5 | 28 |
| Leather Working | 248 | 83.3 | 45 | 15.2 | 293 | 98.5 | 5 | 1.5 | 298 |
| Linoleum Works | 39 | 30.2 | 71 | 55.0 | 110 | 85.2 | 19 | 14.8 | 129 |
| Linseed Oil Works | 29 | 55.8 | 15 | 28.9 | 44 | 84.7 | 8 | 15.3 | 52 |
| Lumber Yards | 6 | 60.0 | 4 | 40.0 | 10 | 100.0 | 0 | .. | 10 |
| Macaroni Factories | 13 | 65.0 | 5 | 25.0 | 18 | 90.0 | 2 | 10.0 | 20 |
| Machine Shops and Works | 514 | 72.7 | 160 | 22.6 | 674 | 95.3 | 33 | 4.7 | 707 |
| Mail Order Houses | 67 | 87.0 | 10 | 13.0 | 77 | 100.0 | 0 | .. | 77 |
| Match Factories | 75 | 76.5 | 18 | 18.4 | 93 | 94.9 | 5 | 4.1 | 98 |
| Mattress Factories | 675 | 71.4 | 254 | 26.8 | 929 | 98.2 | 17 | 1.8 | 946 |

| | Extinguished Fire | | Held Fire in Check | | Total Satisfactory | | Unsatisfactory | | Total No. of Fires |
|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | |
| Mercantile (Miscellaneous) | 1125 | 82.7 | 204 | 15.0 | 1329 | 97.7 | 31 | 2.3 | 1360 |
| Metal Reduction Plants | 11 | 64.7 | 6 | 35.3 | 17 | 100.0 | 0 | .. | 17 |
| Metal Workers† | 1349 | 65.1 | 642 | 31.0 | 1991 | 96.1 | 81 | 3.9 | 2072 |
| Mining Property | 5 | 62.5 | 2 | 25.0 | 7 | 87.5 | 1 | 12.5 | 8 |
| Mirror Mfg. | 22 | 88.0 | 2 | 8.0 | 24 | 96.0 | 1 | 4.0 | 25 |
| Miscellaneous | 450 | 75.1 | 125 | 20.9 | 575 | 96.0 | 23 | 4.0 | 598 |
| Motion Picture Exchanges | 55 | 76.4 | 14 | 19.5 | 69 | 95.9 | 3 | 4.1 | 72 |
| Motion Picture Studios | 44 | 75.9 | 14 | 24.1 | 58 | 100.0 | 0 | .. | 58 |
| Motion Picture Theatres | 94 | 80.3 | 17 | 14.6 | 111 | 94.9 | 6 | 5.1 | 117 |
| Multiple Occupancy | 140 | 79.1 | 23 | 13.0 | 163 | 92.1 | 14 | 7.9 | 177 |
| Munition Plants | 25 | 42.4 | 24 | 40.7 | 49 | 83.1 | 10 | 16.9 | 59 |
| Musical Instrument Factories | 168 | 70.4 | 64 | 26.8 | 232 | 97.2 | 7 | 2.8 | 239 |
| Office Buildings | 117 | 88.7 | 15 | 11.3 | 132 | 100.0 | 0 | .. | 132 |
| Oil Cloth Works | 33 | 49.3 | 27 | 40.3 | 60 | 89.6 | 7 | 10.4 | 67 |
| Oil Clothing Factories | 26 | 92.8 | 1 | 3.6 | 27 | 96.4 | 1 | 3.6 | 28 |
| Oil Distributing Stations | 2 | 40.0 | 3 | 60.0 | 5 | 100.0 | 0 | .. | 5 |
| Oil Refineries—Animal | 4 | 50.0 | 3 | 37.5 | 7 | 87.5 | 1 | 12.5 | 8 |
| Oil Refineries—Mineral | 7 | 58.4 | 4 | 33.3 | 11 | 91.7 | 1 | 8.3 | 12 |
| Oil Refineries—Vegetable | 12 | 46.2 | 11 | 42.4 | 23 | 88.6 | 3 | 11.4 | 26 |
| Optical Works | 22 | 62.9 | 13 | 37.1 | 35 | 100.0 | 0 | .. | 35 |
| Packing Houses | 209 | 68.8 | 82 | 26.9 | 291 | 95.7 | 13 | 4.3 | 304 |
| Paint and Varnish Works | 328 | 66.3 | 148 | 29.9 | 476 | 96.2 | 19 | 3.8 | 495 |
| Paper Coating Mills | 43 | 66.2 | 16 | 24.6 | 59 | 90.8 | 6 | 9.2 | 65 |
| Paper Mills | 726 | 53.0 | 522 | 38.1 | 1248 | 91.1 | 121 | 8.9 | 1369 |
| Paper Working | 438 | 76.6 | 122 | 21.3 | 560 | 97.9 | 12 | 2.1 | 572 |
| Peanut Roasting Plants | 7 | 58.4 | 2 | 16.6 | 9 | 75.0 | 3 | 25.0 | 12 |
| Phonograph Works | 34 | 68.0 | 14 | 28.0 | 48 | 96.0 | 2 | 4.0 | 50 |
| Photo Camera and Film Mfg. | 21 | 65.7 | 11 | 34.3 | 32 | 100.0 | 0 | .. | 32 |
| Photo Engraving and Studios | 63 | 87.5 | 8 | 11.1 | 71 | 98.6 | 1 | 1.4 | 72 |
| Picture Frame Mfg. | 66 | 67.4 | 26 | 26.6 | 92 | 94.0 | 6 | 6.0 | 98 |
| Piers and Wharves | 25 | 54.3 | 18 | 39.2 | 43 | 93.5 | 3 | 6.5 | 46 |
| Plumbers' Supplies | 42 | 73.7 | 12 | 21.0 | 54 | 94.7 | 3 | 5.3 | 57 |
| Potteries | 62 | 64.6 | 26 | 27.1 | 88 | 91.7 | 8 | 8.3 | 96 |
| Printing and Lithographing | 1259 | 82.8 | 237 | 15.6 | 1496 | 98.4 | 25 | 1.6 | 1521 |
| Prisons | 5 | 45.4 | 4 | 36.4 | 9 | 81.8 | 2 | 18.2 | 11 |
| Public Buildings | 10 | 71.4 | 3 | 21.5 | 13 | 92.9 | 1 | 7.1 | 14 |
| Pulp Mills | 53 | 39.5 | 55 | 41.1 | 108 | 80.6 | 26 | 19.4 | 134 |
| Pyroxylin Plastic Mfg. Fabricating | 278 | 68.6 | 88 | 21.7 | 366 | 90.3 | 40 | 9.7 | 406 |
| Radios and Accessories | 65 | 83.4 | 11 | 14.1 | 76 | 97.5 | 2 | 2.5 | 78 |
| Railroad—Misc. Property | 5 | 31.2 | 10 | 62.5 | 15 | 93.7 | 1 | 6.3 | 16 |
| Railroad—Repair Shops | 4 | 40.0 | 6 | 60.0 | 10 | 100.0 | 0 | .. | 10 |
| Rayon Mills | 30 | 83.4 | 4 | 11.1 | 34 | 94.5 | 2 | 5.5 | 36 |
| Restaurants | 199 | 74.5 | 65 | 24.3 | 264 | 98.8 | 3 | 1.2 | 267 |
| Rice Mills | 2 | 25.0 | 2 | 25.0 | 4 | 50.0 | 4 | 50.0 | 8 |
| Rolling, Wire and Tube Mills | 92 | 65.7 | 43 | 30.7 | 135 | 96.4 | 5 | 3.6 | 140 |
| Roofing Works | 49 | 36.6 | 74 | 55.2 | 123 | 91.8 | 11 | 8.2 | 134 |
| Rooming and Lodging Houses | 10 | 91.0 | 0 | .. | 10 | 91.0 | 1 | 9.0 | 11 |
| Rubber Cloth Factories | 83 | 68.0 | 35 | 28.7 | 118 | 96.7 | 4 | 3.3 | 122 |
| Rubber Reclaiming Works | 23 | 56.2 | 9 | 21.9 | 32 | 78.1 | 9 | 21.9 | 41 |
| Rubber Mills | 313 | 56.8 | 209 | 38.1 | 522 | 94.9 | 28 | 5.1 | 550 |
| Salt Works | 2 | 50.0 | 2 | 50.0 | 4 | 100.0 | 0 | .. | 4 |
| Saw and Planing Mills | 123 | 41.6 | 94 | 31.7 | 217 | 73.3 | 79 | 26.7 | 296 |
| Schools—Colleges and Universities | 21 | 87.5 | 3 | 12.5 | 24 | 100.0 | 0 | .. | 24 |
| Schools—Private | 7 | 70.0 | 2 | 20.0 | 9 | 90.0 | 1 | 10.0 | 10 |
| Schools—Public | 9 | 64.3 | 2 | 14.3 | 11 | 78.6 | 3 | 21.4 | 14 |
| Schools—Trade and Industrial | 14 | 82.4 | 2 | 11.7 | 16 | 94.1 | 1 | 5.9 | 17 |
| Shipyards | 16 | 55.2 | 12 | 41.4 | 28 | 96.6 | 1 | 3.4 | 29 |
| Shoddy Mills | 279 | 65.7 | 122 | 28.7 | 401 | 94.4 | 24 | 5.6 | 425 |
| Shoe Factories | 1027 | 75.4 | 286 | 21.0 | 1313 | 96.4 | 49 | 3.6 | 1362 |
| Shoe Mfg. Accessories | 108 | 70.1 | 39 | 25.4 | 147 | 95.5 | 7 | 4.5 | 154 |

| | Extinguished Fire | | Held Fire in Check | | Total Satisfactory | | Unsatisfactory | | Total No. of Fires |
|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | |
| Shoe Stores | 86 | 87.8 | 12 | 12.2 | 98 | 100.0 | 0 | .. | 98 |
| Silk Mills | 197 | 81.8 | 36 | 14.9 | 233 | 96.7 | 8 | 3.3 | 241 |
| Smelting and Refining | 8 | 66.7 | 4 | 33.3 | 12 | 100.0 | 0 | .. | 12 |
| Soap Manufacturing | 59 | 72.0 | 20 | 24.3 | 79 | 96.3 | 3 | 3.7 | 82 |
| Stables | 23 | 74.3 | 8 | 25.7 | 31 | 100.0 | 0 | .. | 31 |
| Stamping and Sheet Metal Works | 198 | 62.9 | 99 | 31.4 | 297 | 94.3 | 18 | 5.7 | 315 |
| Starch and Glucose | 16 | 55.2 | 5 | 17.2 | 21 | 72.4 | 8 | 27.6 | 29 |
| Stone Working | 4 | 100.0 | 0 | .. | 4 | 100.0 | 0 | .. | 4 |
| Sugar Refineries | 41 | 52.6 | 34 | 43.6 | 75 | 96.2 | 3 | 3.8 | 78 |
| Tannery Class A** | 22 | 42.3 | 25 | 48.1 | 47 | 90.4 | 5 | 9.6 | 52 |
| Tannery Class B** | 136 | 57.4 | 81 | 34.1 | 217 | 91.5 | 20 | 8.5 | 237 |
| Tannery Class C** | 19 | 43.2 | 20 | 45.4 | 39 | 88.6 | 5 | 11.4 | 44 |
| Tannery Class D** | 29 | 70.7 | 10 | 24.4 | 39 | 95.1 | 2 | 4.9 | 41 |
| Telephone Exchanges | 3 | 100.0 | 0 | .. | 3 | 100.0 | 0 | .. | 3 |
| Tenant Manufacturing | 1875 | 79.3 | 401 | 16.9 | 2276 | 96.2 | 89 | 3.8 | 2365 |
| Theatres | 99 | 76.8 | 23 | 17.8 | 122 | 94.6 | 7 | 5.4 | 129 |
| Tobacco Factories | 98 | 76.0 | 27 | 20.9 | 125 | 96.9 | 4 | 3.1 | 129 |
| Tobacco Warehouses | 8 | 61.5 | 4 | 30.8 | 12 | 92.3 | 1 | 7.7 | 13 |
| Trunk Factories | 43 | 71.7 | 10 | 16.7 | 53 | 88.4 | 7 | 11.6 | 60 |
| Umbrella Mfg. | 22 | 81.5 | 4 | 14.8 | 26 | 96.3 | 1 | 3.7 | 27 |
| Vinegar Works | 1 | 100.0 | 0 | .. | 1 | 100.0 | 0 | .. | 1 |
| Wall Paper Factories | 28 | 73.7 | 6 | 15.8 | 34 | 89.5 | 4 | 10.5 | 38 |
| Warehouses | 518 | 75.0 | 142 | 20.6 | 660 | 95.6 | 30 | 4.4 | 690 |
| Waste and Batting Mills | 404 | 60.5 | 234 | 34.0 | 638 | 94.5 | 30 | 4.5 | 668 |
| Waste Paper and Rag Shops | 279 | 65.1 | 127 | 29.6 | 406 | 94.7 | 23 | 5.3 | 429 |
| Water Works | 1 | 33.3 | 2 | 66.7 | 3 | 100.0 | 0 | .. | 3 |
| Weaving Mills | 207 | 69.0 | 85 | 28.3 | 292 | 97.3 | 8 | 2.7 | 300 |
| Window Shade Factories | 17 | 74.0 | 4 | 17.3 | 21 | 91.3 | 2 | 8.7 | 23 |
| Woodworker, Class A* | 214 | 55.0 | 123 | 31.7 | 337 | 86.7 | 52 | 13.3 | 389 |
| Woodworker, Class B* | 211 | 53.2 | 147 | 37.2 | 358 | 90.4 | 38 | 9.6 | 396 |
| Woodworker, Class C* | 211 | 61.8 | 111 | 32.4 | 322 | 94.2 | 20 | 5.8 | 342 |
| Woodworker, Class D* | 143 | 57.2 | 83 | 33.2 | 226 | 90.4 | 24 | 9.6 | 250 |
| Woodworker, Class E* | 202 | 64.4 | 95 | 30.2 | 297 | 94.6 | 17 | 5.4 | 314 |
| Woodworker, Class F* | 49 | 60.5 | 27 | 33.3 | 76 | 93.8 | 5 | 6.2 | 81 |
| Woodworker, Class G* | 2 | 16.7 | 9 | 75.0 | 11 | 91.7 | 1 | 8.3 | 12 |
| Woodworker, Class H* | 93 | 78.9 | 24 | 20.3 | 117 | 99.2 | 1 | .8 | 118 |
| Woolen Mills | 1240 | 70.2 | 448 | 25.3 | 1688 | 95.5 | 80 | 4.5 | 1768 |
| Wool Scouring Plants | 44 | 68.8 | 17 | 26.5 | 61 | 95.3 | 3 | 4.7 | 64 |
| Wool Storehouses | 35 | 68.6 | 13 | 25.5 | 48 | 94.1 | 3 | 5.9 | 51 |
| Worsted Mills | 106 | 60.9 | 53 | 30.5 | 159 | 91.4 | 15 | 8.6 | 174 |
| Total | 38892 | | 14539 | | 53431 | | 2236 | | 55667 |

*The Woodworkers are classified as follows:

Class A. Interior Woodwork, builders' supplies (including veneer works).

Class B. Box Factories (including cigar boxes).

Class C. Miscellaneous Woodworkers. Steam power tenant Woodworkers. Woodworkers where there is a lack of detailed information as to class.

Class D. Sash, Door and Blind Factories.

Class E. Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc., last and wood heel factories).

Class F. Pails and Woodenware (plates, wooden bowls, tubs, etc.).

Class G. Wood Flour Mills.

†Other Metal Working Occupancies are included under Agricultural Implements; Automobile and Bicycle Factories; Bolt, Nut and Screw Works; Electrical Appliances; Forge and Smithy; Foundries; Machine Works; Rolling, Wire and Tube Works; and Stamping and Sheet Metal Works.

**The Tanneries are classified as follows:

Class A. Sole Leather and Belting.

Class B. Upper Leather (Calfskins, Sheepskins, Morocco).

Class C. Patent Leather.

Class D. Skin Mills (Glove Leather).

## Table No. 5—Classification of Unsatisfactory Sprinkler Fires by Occupancy.

| | Water shut off sprinklers. | Generally defective equipment and unsprinklered portions. | Defective water supply or supplies. | Sprinkler system crippled due to freezing. | Slow operation of dry system or defective dry valve. | Slow or defective operation of high test heads. | Faulty building construction, concealed spaces, vertical openings. | Obstruction to distribution. | Hazard of occupancy too severe for average sprinkler equipment. | Sprinkler system crippled by explosion. | Exposure or conflagration. | Plugged heads. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abrasive Works | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 2 |
| Agricultural Implements | 3 | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 5 |
| Alcohol Distilleries | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| Aluminum Works | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 1 | .. | .. | .. | 2 |
| Amusement Places | 2 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | 1 | .. | 4 |
| Artificial Leather Mfg. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 2 | .. | .. | .. | 3 |
| Asbestos Works | .. | .. | 2 | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 3 |
| Automobile Mfg. | 8 | 3 | 2 | .. | 1 | .. | .. | 4 | .. | 2 | 1 | .. | .. | 21 |
| Automobile Body Mfg. | 4 | 6 | 3 | .. | 2 | .. | 1 | 2 | 1 | 1 | 3 | 1 | 1 | 25 |
| Auto Sales and Service | 3 | 1 | .. | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 6 |
| Bag Factories | 1 | .. | .. | .. | .. | 1 | .. | 1 | .. | .. | .. | 1 | .. | 4 |
| Bakeries | 4 | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 2 | 8 |
| Basket Factories | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 1 |
| Battery Mfg. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 3 |
| Bolt, Nut, and Screw Works | 1 | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Bottling Works | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Braid Mills | .. | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 2 |
| Brass and Copper Works | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 3 |
| Broom Factories | 3 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Brush Factories | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Button Factories | .. | .. | .. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Candy Factories | 4 | .. | .. | 1 | 1 | .. | 2 | .. | 1 | .. | 1 | .. | 1 | 11 |
| Canneries | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | 3 |
| Car Houses | 2 | 3 | 1 | .. | 1 | .. | .. | 1 | .. | .. | .. | 1 | .. | 9 |
| Car Works | 2 | 1 | .. | .. | .. | .. | 1 | 1 | .. | .. | .. | .. | .. | 5 |
| Carpet and Rug Mills | 4 | 2 | 3 | .. | .. | .. | .. | 2 | .. | .. | .. | .. | .. | 11 |
| Casket Mfg. | 2 | .. | .. | 1 | 1 | .. | 1 | .. | .. | .. | .. | .. | .. | 5 |
| Cement and Plaster Mills | 1 | 1 | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Cereal Mills | .. | 2 | 1 | .. | .. | .. | .. | 1 | .. | 4 | .. | .. | .. | 8 |
| Chemical & White Lead Wks. | 3 | 6 | .. | .. | .. | .. | .. | 1 | 5 | 8 | 1 | .. | 1 | 25 |
| Clothing Mfg. | 6 | 2 | 2 | 1 | .. | .. | 4 | 2 | .. | .. | 2 | 1 | 2 | 22 |
| Clubs—City | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 1 |
| Coal and Wood Yards | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Coffee and Spice Mills | 2 | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | .. | .. | .. | 4 |
| Cooperage Plants | 1 | 4 | .. | .. | .. | 1 | .. | 4 | .. | .. | 2 | .. | .. | 12 |
| Cordage Works | 5 | 5 | 1 | 1 | .. | .. | .. | 3 | .. | .. | .. | .. | 1 | 16 |
| Cork Factories | 1 | .. | 1 | .. | .. | .. | .. | .. | 1 | 1 | .. | .. | 1 | 5 |
| Cotton Gins | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Cotton Mills | 42 | 27 | 11 | 2 | 2 | 1 | 5 | 3 | 3 | 1 | .. | 5 | 15 | 117 |
| Cotton Seed Oil Mills | 4 | 7 | 4 | .. | .. | .. | .. | .. | 2 | .. | .. | .. | 3 | 20 |
| Cotton Warehouses | 16 | 3 | 7 | .. | 2 | .. | 1 | 7 | 3 | .. | .. | 3 | 4 | 46 |
| Cutlery Mfg. | 1 | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Department Stores | 11 | 4 | 1 | .. | 2 | .. | 1 | 1 | .. | .. | 2 | .. | 1 | 23 |
| Distilleries | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 1 | .. | .. | 3 |
| Drug Mfg. and Warehouses | 2 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 3 | .. | 1 | 7 |
| Dry Goods Stores | 4 | .. | .. | .. | .. | .. | 1 | 1 | .. | .. | .. | .. | .. | 6 |
| Dwellings | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 1 |
| Dyeing, Bleaching, Finishing | 7 | 3 | 1 | .. | 1 | 2 | .. | 2 | .. | .. | 1 | 1 | 1 | 19 |

| | Water shut off sprinklers. | Generally defective equipment and unsprinklered portions. | Defective water supply or supplies. | Sprinkler system crippled due to freezing. | Slow operation of dry system or defective dry valve. | Slow or defective operation of high test heads. | Faulty building construction, concealed spaces, vertical openings. | Obstruction to distribution. | Hazard of occupancy too severe for average sprinkler equipment. | Sprinkler system crippled by explosion. | Exposure or conflagration. | Plugged heads. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Electrical Appliance Mfg... | 3 | .. | 2 | .. | .. | .. | 1 | 2 | .. | 1 | .. | 1 | 3 | 13 |
| Electric Power and Light.. | 1 | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 3 |
| Excelsior Factories ..... | .. | .. | 2 | .. | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | 4 |
| Fertilizer Plants ..... | 2 | 1 | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 4 |
| Fibre Products ..... | 1 | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Fireworks Plants ..... | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| Flax and Linen Mills..... | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Flour and Grist Mills..... | 10 | 4 | 2 | .. | 1 | .. | 1 | 1 | 2 | 6 | 2 | .. | 2 | 31 |
| Forge and Smithy..... | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 1 |
| Foundries ..... | 13 | .. | 1 | .. | 1 | .. | 1 | 1 | .. | 2 | .. | .. | .. | 19 |
| Fur Works ..... | 1 | 1 | .. | .. | .. | .. | 2 | .. | .. | .. | .. | .. | 1 | 5 |
| Furniture Factories ..... | 37 | 23 | 10 | 4 | 1 | .. | 4 | 12 | 12 | 1 | 4 | 3 | 2 | 113 |
| Furniture Stores ..... | 6 | .. | .. | .. | 1 | .. | 1 | .. | .. | .. | .. | .. | .. | 8 |
| Garages ..... | 11 | .. | .. | 2 | 1 | .. | .. | 3 | .. | 1 | .. | .. | 1 | 19 |
| Garbage Reduction Plants.. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Gas Works ..... | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Glass Factories ..... | 4 | 4 | 2 | 1 | .. | .. | 3 | 1 | .. | .. | .. | .. | 3 | 18 |
| Glove Factories ..... | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Glue Factories ..... | 2 | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | 3 |
| Grain Elevators ..... | 1 | 5 | 5 | .. | 4 | .. | 2 | 1 | 1 | 5 | 2 | .. | 1 | 27 |
| Groceries ..... | 6 | .. | 1 | .. | 1 | .. | 1 | .. | 1 | 1 | .. | .. | .. | 11 |
| Hardware Stores ..... | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 3 |
| Hat Factories ..... | 9 | 4 | 2 | .. | 1 | .. | .. | 2 | .. | .. | .. | .. | 3 | 21 |
| Hotels—Year Round ..... | 2 | 1 | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 5 |
| Hotels—Seasonal ..... | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 1 |
| Ice Houses ..... | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Idle and Vacant Property... | 16 | 1 | .. | 3 | .. | .. | 1 | 1 | .. | .. | 1 | 1 | .. | 24 |
| Insulated Wire Works..... | .. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Jewelry Factories ..... | 4 | 1 | .. | 2 | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 8 |
| Junk Shops ..... | 3 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | 5 |
| Knitting Mills—Cop Yarn.. | 1 | 1 | 3 | .. | .. | .. | .. | 1 | .. | 1 | .. | .. | .. | 7 |
| Knitting Mills—Full Process | 10 | 10 | 6 | 1 | 1 | .. | 1 | .. | .. | 1 | .. | 1 | .. | 31 |
| Lamp Shade Factories..... | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Laundries ..... | 5 | .. | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 7 |
| Lead Pencil Factories..... | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| Leather Working ..... | 1 | .. | 1 | .. | 1 | .. | .. | 1 | .. | .. | .. | .. | 1 | 5 |
| Linoleum Works ..... | .. | 8 | 1 | .. | .. | .. | 1 | 2 | 7 | .. | .. | .. | .. | 19 |
| Linseed Oil Works..... | 1 | 1 | .. | .. | .. | .. | 1 | .. | 1 | 2 | .. | 2 | .. | 8 |
| Macaroni Factories ..... | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Machine Shops and Works. | 19 | 6 | 1 | 1 | .. | 1 | .. | .. | 1 | 2 | .. | 2 | .. | 33 |
| Match Factories ..... | 2 | .. | .. | .. | .. | .. | .. | .. | 2 | .. | .. | .. | 1 | 5 |
| Mattress Factories ..... | 12 | 2 | .. | 1 | .. | .. | .. | 2 | .. | .. | .. | .. | .. | 17 |
| Mercantile (Miscellaneous). | 11 | 6 | 1 | 2 | .. | .. | 5 | .. | .. | .. | 4 | .. | 2 | 31 |
| Metal Workers† ..... | 26 | 18 | 4 | 1 | 1 | 2 | 5 | 4 | 6 | 5 | 3 | 2 | 4 | 81 |
| Mining Property ..... | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Mirror Mfg. ..... | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 1 |
| Miscellaneous ..... | 4 | 4 | 1 | .. | 2 | 1 | 3 | .. | 5 | .. | 1 | .. | 2 | 23 |
| Motion Picture Exchanges.. | .. | .. | .. | .. | 1 | .. | .. | .. | 2 | .. | .. | .. | .. | 3 |
| Motion Picture Theatres... | 2 | 1 | .. | .. | .. | .. | .. | 1 | .. | 1 | 1 | .. | .. | 6 |

| | Water shut off sprinklers. | Generally defective equipment and unsprinklered portions. | Defective water supply or supplies. | Sprinkler system crippled due to freezing. | Slow operation of dry system or defective dry valve. | Slow or defective operation of high test heads. | Faulty building construction, concealed spaces, vertical openings. | Obstruction to distribution. | Hazard of occupancy too severe for average sprinkler equipment. | Sprinkler system crippled by explosion. | Exposure or conflagration. | Plugged heads. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Multiple Occupancy | 3 | 1 | .. | 1 | 1 | .. | 5 | .. | .. | 2 | .. | .. | 1 | 14 |
| Munition Plants | 2 | .. | .. | 1 | .. | .. | .. | .. | 4 | 2 | .. | .. | 1 | 10 |
| Musical Instrum't Factories | 1 | 4 | .. | .. | .. | .. | 1 | .. | .. | .. | 1 | .. | .. | 7 |
| Oil Cloth Works | .. | .. | .. | .. | .. | .. | .. | 1 | 6 | .. | .. | .. | .. | 7 |
| Oil Clothing Factories | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 1 |
| Oil Refineries—Animal | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Oil Refineries—Mineral | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | 1 |
| Oil Refineries—Vegetable | 2 | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Packing Houses | 5 | 2 | 1 | .. | 2 | .. | .. | .. | 1 | 1 | .. | .. | 1 | 13 |
| Paint and Varnish Works | 3 | 3 | 5 | .. | 1 | .. | 3 | 1 | .. | 3 | .. | .. | .. | 19 |
| Paper Coating Mills | 2 | .. | .. | .. | .. | .. | .. | 2 | .. | 1 | .. | .. | 1 | 6 |
| Paper Mills | 28 | 26 | 18 | 5 | 2 | 3 | 2 | 9 | 4 | 3 | 3 | 3 | 15 | 121 |
| Paper Working | 6 | 1 | .. | .. | 1 | .. | .. | 2 | 1 | .. | .. | 1 | .. | 12 |
| Peanut Roasting Plants | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | 2 | .. | .. | 3 |
| Phonograph Works | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Photo Engraving & Studios | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Picture Frame Mfg. | 1 | 2 | 1 | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 6 |
| Piers and Wharves | .. | 2 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Plumbers' Supplies | 2 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Potteries | 3 | 2 | 1 | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 8 |
| Printing and Lithographing | 11 | 5 | 1 | .. | .. | .. | 2 | 1 | 1 | .. | 3 | .. | 1 | 25 |
| Prisons | .. | .. | .. | .. | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | 2 |
| Public Buildings | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Pulp Mills | 11 | 4 | 4 | .. | 1 | 1 | 1 | .. | 1 | 1 | .. | .. | 2 | 26 |
| Pyroxylin Plastic Mfg. and Fabricating | 3 | 1 | 3 | 1 | 1 | .. | 2 | 2 | 19 | 6 | 2 | .. | .. | 40 |
| Radios and Accessories | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 2 |
| Railroad—Misc. Property | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 1 |
| Rayon Mills | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 2 |
| Restaurants | 1 | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 3 |
| Rice Mills | .. | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 | 4 |
| Rolling, Wire & Tube Mills | .. | 1 | .. | .. | 1 | 1 | 1 | .. | .. | .. | .. | 1 | .. | 5 |
| Roofing Works | 3 | 2 | 1 | 1 | .. | .. | 1 | 2 | .. | 1 | .. | .. | .. | 11 |
| Rooming & Lodging Houses | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Rubber Cloth Factories | 2 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 4 |
| Rubber Reclaiming Works | 3 | .. | .. | .. | .. | .. | 1 | 1 | 2 | 1 | 1 | .. | .. | 9 |
| Rubber Mills | 9 | 1 | .. | 1 | .. | .. | .. | 1 | 7 | 7 | .. | 1 | 1 | 28 |
| Saw and Planing Mills | 20 | 15 | 7 | 1 | 6 | 1 | 6 | 4 | 8 | .. | 5 | 1 | 5 | 79 |
| Schools—Private | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Schools—Public | 1 | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 3 |
| Schools—Trade & Industrial | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Shipyards | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Shoddy Mills | 6 | 3 | 7 | 1 | 1 | 3 | 1 | 1 | .. | .. | .. | .. | 1 | 24 |
| Shoe Factories | 19 | 8 | 3 | .. | 1 | 1 | 2 | 3 | .. | 3 | 6 | .. | 3 | 49 |
| Shoe Mfg. Accessories | 3 | 2 | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 7 |
| Silk Mills | 3 | 2 | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 2 | 8 |
| Soap Manufacturing | 2 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Stamping & Sht. Metal Wks. | 4 | 5 | 1 | .. | 1 | .. | 2 | 1 | .. | 1 | 2 | .. | 1 | 18 |
| Starch and Glucose Works | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 7 | .. | .. | .. | 8 |

| | Water shut off sprinklers. | Generally defective equipment and unsprinklered portions. | Defective water supply or supplies. | Sprinkler system crippled due to freezing. | Slow operation of dry system or defective dry valve. | Slow or defective operation of high test heads. | Faulty building construction, concealed spaces, vertical openings. | Obstruction to distribution. | Hazard of occupancy too severe for average sprinkler equipment. | Sprinkler system crippled by explosion. | Exposure or conflagration. | Plugged heads. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sugar Refineries | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 3 |
| Tannery, Class A** | 1 | 1 | .. | 1 | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | 5 |
| Tannery, Class B** | 8 | 4 | .. | 2 | 3 | .. | 1 | 1 | .. | .. | .. | .. | 1 | 20 |
| Tannery, Class C** | 1 | .. | 1 | 1 | .. | .. | 1 | .. | .. | .. | 1 | .. | .. | 5 |
| Tannery, Class D** | .. | .. | .. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Tenant Manufacturing | 52 | 9 | 2 | 4 | 1 | .. | 3 | 3 | 2 | 1 | 7 | 2 | 3 | 89 |
| Theatres | 4 | 3 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 7 |
| Tobacco Factories | 1 | 1 | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | .. | .. | 4 |
| Tobacco Warehouses | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 1 |
| Trunk Factories | 3 | 1 | 1 | .. | .. | .. | 1 | .. | .. | .. | 1 | .. | .. | 7 |
| Umbrella Mfg. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| Wall Paper Factories | .. | .. | 1 | .. | .. | .. | .. | 1 | 1 | .. | 1 | .. | .. | 4 |
| Warehouses | 11 | 3 | 3 | .. | 2 | .. | 3 | 2 | 2 | .. | .. | 1 | 3 | 30 |
| Waste and Batting Mills | 8 | 4 | 5 | 2 | 2 | 1 | .. | 2 | 2 | .. | .. | 3 | 1 | 30 |
| Waste Paper & Rag Sorting | 12 | 4 | 1 | 3 | .. | .. | .. | 1 | .. | .. | .. | .. | 2 | 23 |
| Weaving Mills | 1 | 2 | 2 | 1 | .. | .. | .. | 2 | .. | .. | .. | .. | .. | 8 |
| Window Shade Factories | .. | .. | .. | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | 2 |
| Woodworker, Class A* | 13 | 10 | 5 | 1 | 2 | 1 | 2 | 6 | 1 | 3 | 3 | 1 | 4 | 52 |
| Woodworker, Class B* | 10 | 9 | 3 | 3 | 1 | 2 | 1 | 1 | .. | 3 | 2 | 3 | .. | 38 |
| Woodworker, Class C* | 7 | 5 | 3 | .. | .. | .. | 1 | 3 | .. | .. | .. | .. | 1 | 20 |
| Woodworker, Class D* | 3 | 10 | .. | 1 | 1 | .. | .. | .. | .. | 2 | 4 | .. | 3 | 24 |
| Woodworker, Class E* | 6 | 1 | 1 | .. | 2 | 1 | 2 | .. | 1 | .. | 1 | 1 | 1 | 17 |
| Woodworker, Class F* | 2 | 1 | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 5 |
| Woodworker, Class G* | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| Woodworker, Class H* | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Woolen Mills | 21 | 21 | 16 | 2 | .. | 2 | 4 | 1 | 1 | .. | 3 | .. | 9 | 80 |
| Wool Scouring Plants | .. | 1 | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 3 |
| Wool Storehouses | 1 | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Worsted Mills | 3 | 4 | 2 | 1 | .. | .. | 1 | .. | .. | .. | .. | .. | 4 | 15 |
| Total | 724 | 395 | 197 | 68 | 71 | 27 | 111 | 133 | 127 | 109 | 89 | 47 | 138 | 2236 |

†See note on Metal Workers under Table No. 4.
*See detailed classification of Woodworkers as given in note under Table 4.
**See detailed classification of Tanneries as given in note under Table No. 4.

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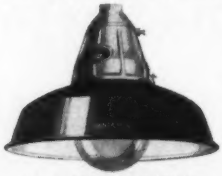

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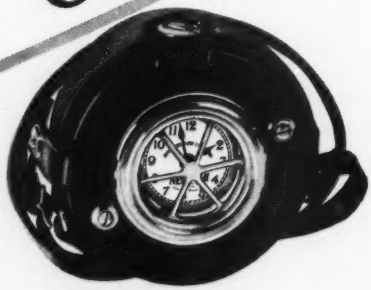

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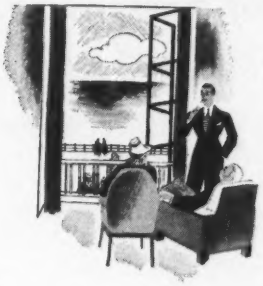

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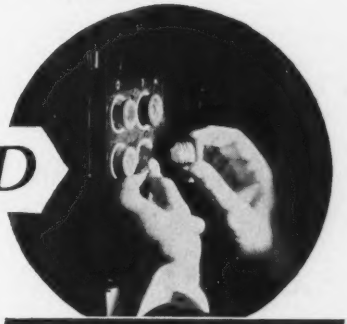

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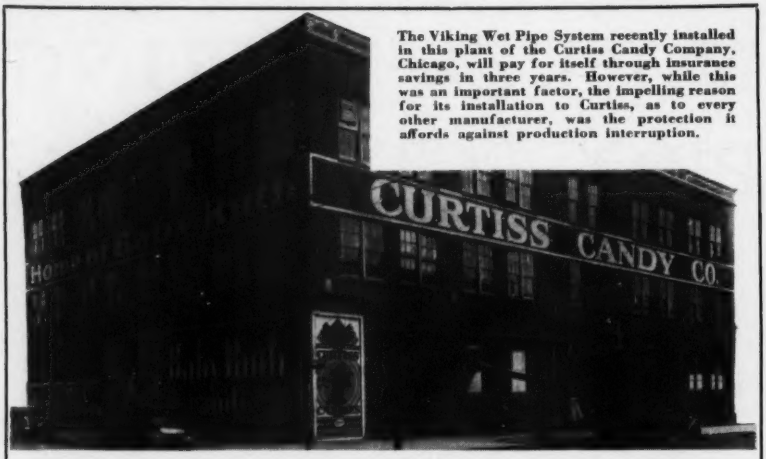


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